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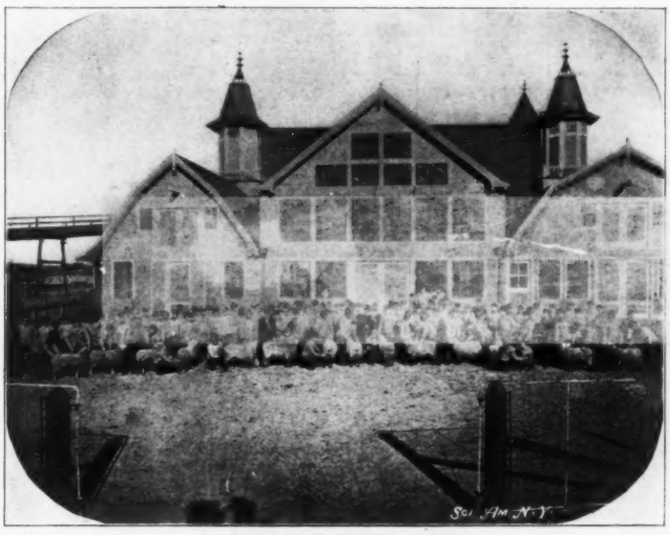
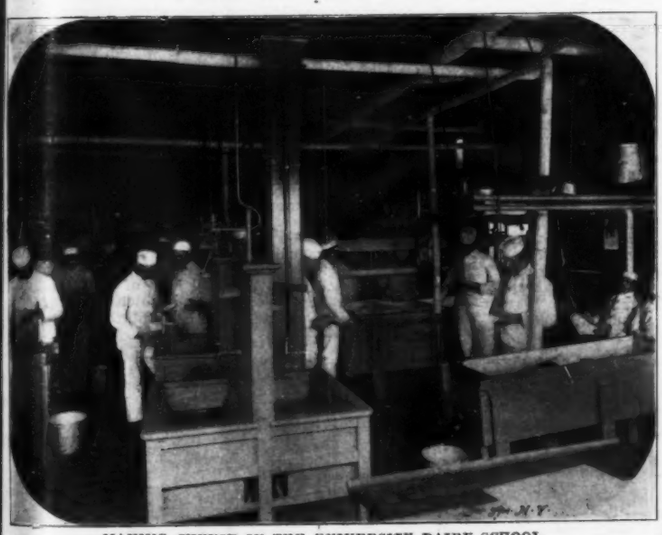
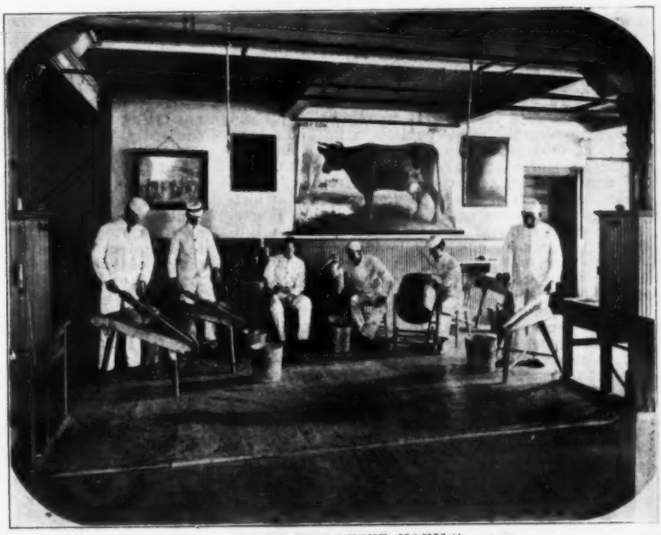
THE NEW AGRICULTURAL HALL.



A LESSON IN HANDLING SHEEP.



MAKING CHEESE IN THE UNIVERSITY DAIRY SCHOOL.



A LECTURE ON BUTTER MAKING.

STUDYING THE EFFECTS OF FERTILIZERS ON VARIOUS PLANTS.

STUDYING PLANTS IN THE HORTICULTURAL LABORATORY.

THE AGRICULTURAL COLLEGE OF THE OHIO STATE UNIVERSITY.

## THE AGRICULTURAL COLLEGE OF THE OHIO STATE UNIVERSITY.*

By DAY ALLEN WILLEY.

THE rapid increase in the number of agricultural colleges throughout the country is partly responsible for the remarkable improvement which has been noted in the methods of farming, especially in those States

THE UNIVERSITY DAIRY BARN AND STOCK JUDGING BUILDING.

which are so fortunate as to possess these institutions. The agitation in favor of giving the agriculturist a so-called higher education has perhaps become more extensive in the West, and especially in the States beyond the Mississippi River, than in other parts of the country, but deep interest is manifested in the East, as is shown by the facilities which are provided at such institutions as Cornell and Harvard.

It is a noticeable fact that many of the larger institutions of this class are the result of State aid. For example, the State University, which is located at Columbus, O., really represents six colleges, one of which is devoted to agriculture and domestic science. It has an attendance of over one thousand students, several hundred of whom confine their studies to the agricultural department, while a very large proportion of the faculty, which comprises nearly eighty professors and assistants, are specialists in branches pertaining to the field, orchard, garden, and other subjects which enter into the career of the farmer. The State of Kansas has made a very liberal appropriation for the Kansas Agricultural College, which, as its name indicates, is devoted to the subject referred to, and has an attendance of about eight hundred students. Another excellent illustration of the modern college is that connected with the University of Wisconsin, which is the most completely equipped in the United States. It has been established in connection with the University of Wisconsin, and four buildings are devoted to this division, not counting the barns, greenhouses, and other structures which are required largely for experimental and field work.

The courses of study provided allow students to enter for different periods, and to perfect themselves in all of the branches or to confine themselves to certain specialties. The wide range of topics considered essential to become a graduate is indicated by the prospectuses issued by some of the Western institutions. The full course in agriculture, for instance, generally includes chemistry of the soil as well as of the dairy, agricultural analysis, meteorology, farm engineering, which means the study of not only farm apparatus proper, but appliances for road making and the building of highways. Soil physics includes drainage and irrigation. Horticulture is divided into that pertaining to the culture of fruit, also ornamental gardening, the planting of flowers, shrubs, etc. Under animal husbandry comes not only the study of the various breeds of live stock, but economic breeding, feeding, and shelter, and veterinary science. Bacteriology is divided into sections relating to the dairy and animal diseases. Dairy husbandry, as it is termed, includes the inspection of milk, creamery, butter making, the manufacture of not only American, but what are termed foreign grades of cheese, such as Neuchatel and Limburger, as well as lectures on milk and cream pasteurization, while the mechanical features of the dairy are studied by actual practice with engines, boilers, the fitting of refrigeration pipes, etc. One of the broadest and most valuable subjects is the course in agricultural economics, in which the pupil becomes conversant with the principles which underlie the prosperity of the farmer.

Perhaps the most instructive feature of the modern method of educating the boy or girl for a life on the farm is the opportunity to engage in the actual pursuits through the facilities provided. All of the colleges referred to, as well as the great majority of other institutions where the various branches of agriculture are taught, have tracts of land of suitable size which form elaborate object lessons. These are entirely worked by the students, and the results obtained are due to their efforts under the supervision of their instructors. In the preparation of the field for the seed, for example, the boy not only has an opportunity to study the various kinds of fertilizers which are most suitable for the soil, but notes the effect of the fertilizer for himself, and in this way becomes far more interested than if he merely acquired the knowledge from the pages of his textbook or from the lips of the professor. In preparing the earth, as he guides the plow through the stubble or uncultivated field he is made familiar with the various kinds of loam, it may be said by actual contact, and the explanation given by the printed page has an interest to him which it would not have otherwise. Studying the best kinds of grain or vegtables to plant in a particular field, he becomes naturally interested in the results, and carries out the various processes attending the cultivation of the crop with enthusiasm. He realizes that the quality and quantity of the harvest depend largely upon his own efforts and the knowledge he has acquired from the instructor and textbook, therefore he familiarizes himself with the particular study in question, as he has a deeper apprehension of its value. His study of botany is made far more interesting by examining the shoots of vegetable and cereal from the time they make their appearance above the soil until their crop is ripened. In freeing the field or grain patch from weeds and in making war upon the various insects which attack tree and vine, the student realizes how his knowledge of entomology and other branches are essential to a successful accomplishment of this work.

The student of horticulture is also given facilities in the orchard, vineyard, and amid the shrubbery which, as already intimated, play perhaps a more important part in completing his education in this respect than the lectures and lessons, and it is the same in the other departments, where boys and girls have a chance actively to perform the duties for which they are fitting themselves. One of the most valuable undoubtedly is the department of animal husbandry, which involves the general care of live stock. Nearly all of the farms attached to the agricultural colleges have cattle, sheep, and hogs of a high grade, which are utilized as models. In caring for the animals the students become familiar with the best kinds of forage, the proper remedies for diseases, and by coming in actual contact with the different species, become judges of their good qualities. The graduate of a modern institution of this kind can quickly determine the good or bad points of a horse, a cow, or a sheep, and as accurately as a live-stock raiser who may have for years engaged in this specialty; but an education in the care of animals naturally includes such branches as dairying, and it may be said that the departments devoted to this branch of instruction are among the most elaborate in connection with the institutions, for in recent years the value of milk and its products has been appreciated more and more. Undoubtedly the remarkable progress which has been made, especially in the West, in the manufacture of butter, cheese, and similar articles is due in a great measure to the skill which has been acquired by the graduates of these colleges. As already stated, the idea is to have the pupils perform all of the work themselves, with the view of determining their ability. On some of the larger farms connected with the colleges the surplus product is sold in market in competition with the product of the farmers in the vicinity. This is the case at the University of Wisconsin, which it may be said furnishes a large quantity of the butter, cheese, and cream used in Milwaukee and Madison, while considerable is also sent to Chicago. These compounds are made at the dairy school connected with the university, which converts from 6,000 to 15,000 pounds of milk daily according to the season into the various articles.

In the equipment of the modern agricultural college machinery is a very noticeable feature, as advantage has been taken of important inventions which are very valuable in the saving of labor and time. It may be said that these institutions have kept pace with the times in the installation of such apparatus. In fact, the would-be farmer who takes the full course becomes skilled in certain mechanical branches, which he finds of much value in his chosen vocation. The success which has been attained in the modern dairy, it is unnecessary to say, is largely due to appliances such as power separators, strainers, churns, and freezers. The quality of the compound is also determined by tests which involve the use of apparatus giving the most accurate results. By this method, however, the student can determine the quality of any particular compound, and it is not left so much to guesswork as in the old days of butter and cheese making. When the student realizes that by using an electric, hydraulic, or steam motor with two or three horse power he can churn as much butter or make as much cheese, for example, as twelve or perhaps fifteen persons, he appreciates the value of this mechanical knowledge; but he is also instructed in the mechanism of the traction engine, the plow, the cultivator, the harvester, in fact, all of the ordinary farm machinery. He is taught not only how to operate it, but to take it apart and put it together, in order that he may be able to make any simple repairs needed without the necessity of sending for an expert machinist. Nearly all of the colleges have departments fitted with wood and metal working tools, such as are valuable upon a farm, and instruction in their use is included in the curriculum. The course in drawing is also elaborated sufficiently to include plans for dwellings, barns, greenhouses, and the other necessary structures, so that the graduate who decides to take up a tract of land which is unimproved has the ability to design his own buildings, and perhaps to erect them, or supervise their erection, from the knowledge of carpenter work which he has acquired with his other studies. It may be said that this knowledge of mechanism is playing a very important part in the success which the college-bred farmer is obtaining to-day, especially in the West, and is one reason for the remarkable results which are obtained in diversified agriculture.

According to statistics recently compiled, a conservative estimate places the number of those who graduate yearly from institutions of the class referred to at nearly 10,000. As already stated, some of the agricultural colleges have over five hundred pupils enrolled. Only a portion take the complete course, many endeavoring to make a special study of live-stock raising, horticulture, or some specialty, to which they intend devoting themselves; but the reports indicate that fully twenty per cent of those who leave the colleges yearly have become familiar with modern agriculture in all of its branches. This means that they are not only experts in ordinary field work, but understand fruit growing, the raising and care of live stock and poultry, and indoor occupations which form such a valuable asset. Scattered throughout the country as they are, their methods in themselves form a valuable object lesson to the neighborhood in which they may be located, for the other agriculturists in the vicinity are quick to note the benefit of labor saving machinery, the scientific methods in caring for live stock, the plans by which they rear their trees and plants, cultivate their fields, and the methods they pursue in the interest of economic and scientific agriculture.

TEACHING THE USE OF THE BABCOCK TEST AND OF THE LACTOMETER IN THE DAIRY LABORATORY.

THE AGRICULTURAL COLLEGE OF THE OHIO STATE UNIVERSITY.

* Specially prepared for the SCIENTIFIC AMERICAN SUPPLEMENT.

## THE ALASKA INVESTMENT.

IN the light of some of the gloomy expectations about the purchase in 1867 of the Territory of Alaska heard out of the mouths of men of wide reading and good business judgment, the future of that wonderful section of the country looks like a fairy vision, comparable only with the prodigious development of the Louisiana Purchase earlier in our history, a purchase regarded by some of the reputed wise men of the day as quite as extravagant and wasteful as the acquisition from Russia of a land supposed to be everlastingly coated with ice and productive of nothing more valuable than a diminishing supply of more or less valuable furs.

For a long time the gloomy predictions of those who looked upon the purchase of Alaska as the humoring of an insane delusion—the mere sentimental taking of a worthless area of ice-bound land off Russia's hands—seemed to be justified by the lack of productiveness, and it was not until about 1880 that it began to be found out that Alaska was not an expensive and profitless acquisition, but that it was a veritable land of promise, with resources almost incalculable, much of the land capable of agricultural cultivation, gold and silver everywhere, coal in prodigious deposits; fish of superior quality and in enormous quantities to be had in yearly values exceeding the value of the more alluring gold and silver, timber of exceeding worth awaiting the ax of the woodman, and all the natural resources sufficient to sustain in comfort a population of 3,000,000 people.

When the question was presented in the House of Representatives whether the appropriation of $7,200,000 should be made to enable the government to carry out the treaty by which Secretary Seward agreed to take Alaska from Russia, Gen. B. F. Butler, then a member of the House from Massachusetts, expressed a very general opinion of the unwisdom of the bargain made by the Department of State, when he said:

"If we are to pay for her (Russia's) friendship this amount, I desire to give her the $7,200,000 and let her keep Alaska. . . . I have no doubt that at any time within the last twenty years we could have had Alaska for the asking—I have heard it was so stated in the cabinets of two Presidents—provided we would have taken it as a gift. But no man, except one insane enough to buy the earthquakes in St. Thomas or the icefields in Greenland, could be found to agree to any other terms for its acquisition to the country."

Mr. Loan, of Missouri, another opponent of the treaty bill, held similar opinions. He said:

"The acquisition of this barren and inhospitable waste would never add one dollar to the wealth of our country, or furnish homes to our people. To suppose that any one would willingly leave the mild climate and fruitful soil of the United States, with its newspapers and churches, its railroads and commerce, its civilization and refinement, to seek a home among the Aleuts . . . is simply to suppose such a person insane."

Even as late as 1898, in the House of Representatives, when Alaska had begun to be very productive, and had ceased to excite the fear that it must be governed as an expensive and fruitless gift from Russia, sentiments were expressed showing that the resources of the territory were not appreciated in the place where the very latest and most authentic information of the possibilities of the country were accessible, indicating that there still lingered the belief held and expressed by Gen. Butler, that the United States had taken a white elephant off the hands of Russia, when Alaska was purchased to make good to Russia the cost to that empire of the fleets she had sent to our shores during the civil war in order to manifest her disposition to protect us from the intervention in our affairs of powerful European nations.

It is now some thirty-six years since the United States paid Russia her price for Alaska. The United States bought it, inhabitants and all, and yet escaped the worrying of an anti-imperialist party. There was no end of sneering about the wastefulness of buying a land of ice inhabited by starving savages and the sneers continued to be heard whenever Alaska was mentioned. Yet the books, as they are roughly balanced, show an interesting account. With Alaska just beginning to be imperfectly understood and developed this is the showing:

| | | |
|---|---|---|
| Alaska purchased in 1867 for... | | $7,200,000 |
| Sealskins, value of taken since purchase | $52,000,000 | |
| Salmon, value of taken since purchase | 50,000,000 | |
| Gold, value of taken since discovery | 50,000,000 | |
| Revenues, seal islands, taxes on sealskins, customs, and public lands | 10,000,000 | |
| Total production of Alaska in thirty-six years | | $162,000,000 |
| Excess over purchase price | | 154,800,000 |

This is a pretty good showing from a business point of view, even if the United States should cease to derive anything more from the territory. Ten millions might be added as the amount representing furs other than sealskins, and another ten millions as the value of fish other than salmon. The country has obtained about 215 per cent upon the investment of $7,200,000 thirty-six years ago, or an average of 5 per cent for each year it has owned the territory. As a matter of fact, most of the income has been enjoyed within the last twenty years, and it is still growing and promising to increase in the years to come. The country is prodigious in extent. It is as large as all New England, the Middle States, Virginia, West Virginia, North and South Carolina, Georgia, Florida, Alabama, Mississippi, and Tennessee together. There are 590,000 square miles of it, or about 369,000,000 acres. When the United States took hold of it there was but 30,000 population; now there is a population of 63,000, about half of which is Indian. When the government purchased the territory there were no settlements worth naming except Sitka and St. Michael; now there are towns along several of the rivers and in the interior, all seeking new methods of transportation and looking for the developments that will make it easier and cheaper to get in and out and to obtain the subsistence that it will be necessary to buy out of the territory until its own powers of production of food have been better developed. These towns are all eager for development.

The discovery that Alaska was a great country for the production of salmon was not acted upon until about 1878. The Columbia River then enjoyed the fame of being the great salmon-packing section, and that section was sending its catch all over the world. In that year the Columbia River pack was 460,000 cases, and the Alaska pack was 8,159 cases. In 1888 the Columbia River pack had come to be 367,750 cases, and that of Alaska was 427,372 cases. In 1902 the Columbia River pack was 367,241 cases and that of Alaska was 2,554,423. The total value of the fisheries of Alaska since 1878 is put by government experts at $60,000,000, of which $50,000,000 is to be credited to the salmon fisheries. Very little attention has been paid as yet to the cod fisheries, to halibut, of which there is an abundant supply to be had, and to herring, which is reported to be abundant, but which has as yet not become an important article of consumption.

From 1867 to 1871 the owning of the seal islands did not make the United States much the richer. They did not begin to be productive of revenue to the United States until 1871. Since that year the United States has derived something like $35,000,000 from Alaska in seal skins alone, and something like $17,000,000 from other furs. Besides the value of the seal skins to those who captured and sold the furs, the government has derived income for the privilege of taking the skins and a tax on each skin taken on the government reservations. This seal tax has amounted to upward of $7,500,000; the rent of the seal islands has aggregated something like $1,000,000; there has been an income from customs of $528,558, and from sales of public lands, a small area of which only has recently been accessible to purchasers, of about $20,000.

When anybody hears Alaska talked about, the only product that is thought of by most people is gold. While the production of fish of all kinds has amounted to about $60,000,000 in value, that of gold has been somewhere near $50,000,000, although the statisticians of the Geological Survey can trace but $32,000,000 as the aggregate product since 1895. But the first year of gold production was 1880, when the value of the gold taken was but $6,000. Since then many rich fields have been discovered, the tundra of almost the whole coast below Cape Nome has been prospected, placers are being worked along many streams not yet known to many travelers in Alaska, and, with improved river and railroad transportation, machinery is being taken in with which low-grade ores hitherto neglected are being worked with profit. Not even the most expert and experienced of experts in prospecting will venture to predict what the future of Alaska as a gold-producing country is to be. But there is reason to expect that if Alaska could produce $7,500,000 of gold in 1901, as estimated by Mr. Alfred H. Brooks, of the Geological Survey, it must be assumed, with new placers working and machinery turning the ore beds to account, that the production will increase. It is admitted that so little of the probable gold-bearing country has been explored that there may remain untouched millions of gold in placers of varying richness, while it is certain there are vast areas of gold-bearing quartz to be subjected to the smelter, and much territory already worked over superficially by placer miners that will give profitable returns when subjected to the operation of hydraulic mining.

### BENEFIT TO PACIFIC COAST.

The possession of Alaska has brought business to the Pacific Coast of much importance in the way of strict merchandising. Since 1868 the Territory has taken some $91,000,000 worth of food, clothing, store supplies, machinery, beginning with something like $250,000 in 1868 and amounting to more than $13,000,000 in 1901. Those are unofficial figures. The government report of the imports and exports of Alaska for another year, 1903, gives the shipments of merchandise from the United States to Alaska as reaching about $9,500,000, and the shipments from Alaska to the United States as exceeding $10,000,000.

The Agricultural Department of the United States is doing its best to help the people to get rid of the idea that Alaska is altogether a land of ice and snow, productive of nothing but gold and salmon and seal skins. Over and over again agents of the department have declared that vast areas of the Territory are capable of producing food for men and cattle, that the temperature in much of the Territory is more favorable to white population than countries in Europe that are sustaining larger populations, and that as soon as settlers can be found who will devote themselves to getting something out of the land besides gold, it will sustain a population of at least 3,000,000 people. Trained observers have found that back of the coast, along some of the rivers, there are millions of acres upon which grows grass waist high that will feed myriads of cattle and horses, that those beasts can stand the winters much better than has been imagined, and that in Southern Alaska it is possible to raise barley, oats and wheat, potatoes, cauliflower, cabbage, kale, peas, lettuce, and radishes. Indeed, the experiment stations have proved that most of these things can be raised, and the rather meager statistics of agriculture obtained in Alaska for the Twelfth Census reported the value of the productions of a few farms.

One of the agents of the Agricultural Department considers Alaska much more advantageously located for purposes of agriculture than Finland. That country, one-fourth the size of Alaska, had about 2,600,000 population in 1898, and its population had increased 800,000 in thirty-eight years. Once the ability to raise crops of some of the staples is satisfactorily demonstrated, the population of Alaska will increase, for with cheaper and more abundant food one of the chief obstacles to increase of population will be removed.

### MATTERS UNDER DISCUSSION.

Two matters are being discussed as important to the fuller development of Alaska. One is the extension of the privileges of immigrants seeking permanent homes to acquire larger tracts than may now be taken up under the law. The restriction to eighty acres is considered too small by those who ask for larger allotments to be devoted to range and farming purposes. They would extend the limit to 320 acres. Whether this is too large an area to be sold or given to homesteaders is a question that must be considered in Congress. That body will be in possession of all the latest information to assist its judgment, and will be urged to make laws by many persons personally familiar with the conditions that are now said to retard development. The other important matter for discussion, but also for the consideration of capital, is the establishment of more and better lines of transportation.

Just now there are two routes by which interior Alaska may be reached. By the Skaguay route a railroad helps the business man or tourist to travel some 111 miles toward the headwaters of the Yukon, reaching well in toward the mining camps of that section. By the other route the valley of the Yukon is penetrated from the west by way of St. Michaels and the Yukon River, upon which spacious stream a large fleet of steamboats runs during the open season to Dawson and thereabout. Other railroads are in contemplation, and the companies operating the Yukon steamers are anxiously looking forward to the time when Alaska's coal resources shall be so developed that coal as a fuel may be substituted for the very expensive and rapidly consumed supplies of wood fuel that must be obtained from the wood yards along the banks of the river. There is an abundance of wood, but labor is scarce and high, and does not profit greatly by the sale of cordwood even at the prevailing high rates.

They have cold weather in Alaska, but only a part of the Territory is north of the Arctic circle, and much the greater part of it behind the mountains enjoys a climate of tolerable extremes. The days vary in length oddly to the stranger. In winter in the valley of the Yukon the sun rises about 9 o'clock in the morning and sets at 4 or 5 in the afternoon. During the summer the sun rises at 1.30 in the morning and sets at 9 or 10 o'clock at night. It is during these long summer days that such crops as can be raised are brought to perfection. It is asserted by experts of the Agricultural Department that cattle and horses, abandoned in the interior because their owners could not afford to take them out at the close of the packing season, have successfully wintered, subsisting on the supply of native grasses on the ranges, and surprising those who found them by being in fair condition without human care.

Gen. Butler's predictions have been pretty thoroughly shown to have been made without knowledge of the country upon which they were based. It is probable that Secretary Seward himself did not anticipate the development that Alaska would enjoy in less than forty years. To make predictions now would be hazardous. But if the past is useful for admonition and expectation, it would be perfectly safe to predict that the growth of Alaska in the next thirty-six years will be even more gratifying than has been its wonderful increase in importance and population in the thirty-six years since it was bought from Russia for the price of $7,200,000. Already it exceeds in population the State of Nevada. The value of its gold and salmon exceeds the value of the yearly output of gold by the Nevada mines. When its lumber, fish, coal, and agricultural capabilities have been only partly demonstrated, Nevada, which has few agricultural possibilities to be developed, will in nearly all material respects that constitute a healthful State lag far behind the future empire of the far Northwest.—N. Y. Times.

## STONEHENGE OFFERED TO THE ENGLISH GOVERNMENT.

SIR EDMUND ANTROBUS has, through Lord Edmund Fitzmaurice, chairman of the County Council of Wiltshire, made a definite offer to sell Stonehenge and eight acres of land occupied by these magnificent Druidic ruins to the English government for $250,000, on the understanding that they will be preserved for the nation. Some years ago Sir Edmund made an offer to dispose of Stonehenge and twenty acres of the land on which the great stones stand for $750,000 to any one who was willing to pay that price, and great alarm was expressed lest some American multi-millionaire might purchase the celebrated megalithic monuments and carry them off to the United States. But this fear has not been realized. Sir Edmund's desire to get rid of Stonehenge is in no small measure due to the annoyance to which he has been subjected in the last few years in connection therewith. It was shortly after his accession to the baronetcy and estates on the death of his father in 1899 that he determined to surround Stonehenge, which forms part of his property, with a barbed wire fence, and to charge an admission fee of twenty-five cents, his object being to protect the stones from the injurious treatment to which they were being subjected by people without any reverence for the hoary past. Moreover, as some of the stones were in danger of falling, he feared that in the event of anybody being injured thereby he might be held financially responsible. Exception, however, was taken to his attitude. It was said that inasmuch as Stonehenge had lain open to all the world since English history began, the public had acquired a right-of-way through every portion of the grounds on which the stones stood, and likewise a proprietary interest in the stones themselves. Then, too, it was pointed out that anything in the shape of a modern inclosure destroyed the spell created by the aspect of those immense stones standing alone in strange circles far from human habitation in the midst of a vast, open, rolling plain. And the result was that not only the general public, but likewise men of culture interested in the preservation of national monuments, raised a fund with the object of testing in the courts not Sir Edmund's proprietorship of the ruins, but his right to inclose them with a wire fence.—Marquise de Fontenoy in N. Y. Tribune.

## A SIMPLE AND ECONOMICAL HIGH-VOLTAGE BATTERY.*

By CHARLES J. SULLIVAN.

NUMEROUS attempts, more or less successful, have been made in the past to produce a battery with sufficient power to perform the many practical experiments requiring a voltage of at least fifty.

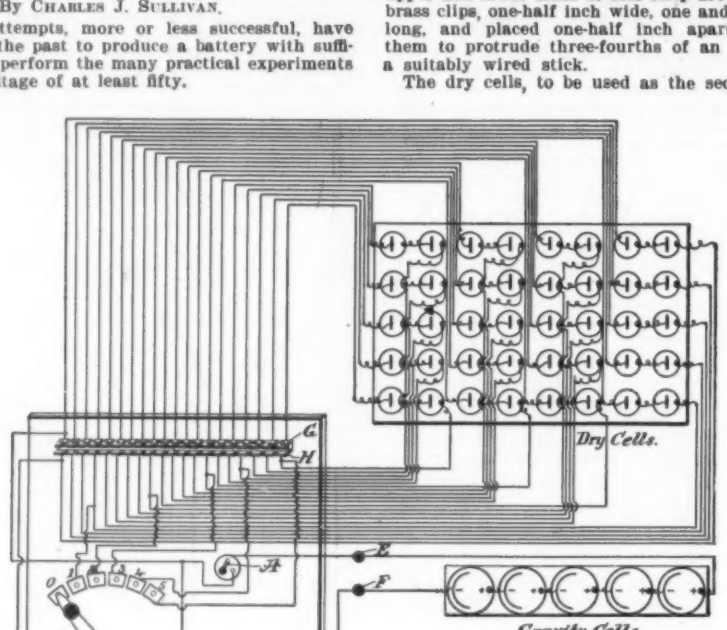



FIG. 2.—CIRCUITS OF THE OUTFIT.

But in all the forms previously used, the great number of cells required, the nuisance of refilling with acids, etc., and the amalgamating of numerous zincs, made the battery a constant source of work and trouble.

Some have advised the charging of accumulators in multiple from gravity cells and discharging in series, to get the required potential. This plan, on account of the cost of making or buying a secondary battery, has been put out of the reach of many.

It is my aim in this article to describe an outfit which requires care for only five gravity cells. The ordinary dry battery answers the purpose of accumulators. This plan, with a suitable switch to change from series to multiple wiring, has worked extremely well with me, and can be quickly and cheaply installed.

The accompanying drawings and photographs will give a very good idea how such a battery may be set up.

The switchboard, two feet long by one and one-half feet high, has attached to it, about six inches from the top, a hard wooden strip two feet long, one-half inch thick, and three-fourths of an inch wide. On the upper and lower sides of this strip are screwed twenty brass clips, one-half inch wide, one and one-half inches long, and placed one-half inch apart. This allows them to protrude three-fourths of an inch to receive a suitably wired stick.

The dry cells, to be used as the secondary battery, are placed on a shelf, five cells deep and eight wide. The cells are arranged in pairs, the two cells of each pair being connected in series as shown in the drawing, and the carbons remaining (twenty) being each connected to one clip on the upper side of the strip on the switchboard, while the zincs are connected to those on the lower side. Care must be taken in attaching the wires to the switchboard that the negative and positive of each pair of cells are connected to clips exactly opposite each other.

Three strips of wood, of the same measurements as the one already attached to the board, are now wired. The first has a strip of brass running nearly full length on both sides (No. 1, Fig. 2) so as to touch all the clips on the upper and lower sides of the switch, thus connecting all the negatives and positives, and when the switch, *A*, is closed, the dry cells are being charged from the gravity battery.

Strip No. 2 in Fig. 2 has four brass strips on each side, each strip being long enough to touch five of the clips on the switch. The first brass strip is connected with the following one on the opposite side, and so on, leaving the first on the rear side and the last on the side facing, unattached. This rod, when placed in the switch, groups the 20 pairs of cells in sets of five each connected in multiple. By moving switch, *L*, to contacts 1, 2, 3, and 4, these four sets may be connected in series, and voltages of 3, 6, 9, and 12 may be obtained.

The last rod, No. 3, Fig. 2, is similar in construction, but made so that each strip of brass touches but one clip. The first brass strip on the side facing is connected by a small piece of copper wire to the following on the opposite, and so on until only the first brass strip on the opposite and the last on the side facing are left unwired. This rod, when placed in the switch, connects all the dry cells in series, and when the switch, *A*, is open and the lever, *L*, is on contact 5, will furnish about sixty volts, provided the dry cells are charged.

In Fig. 1, *A* is the switch used to connect the primary and secondary, and, of course, this should only be closed when the rod No. 1 (Fig. 2) is in the switchboard. Should this switch be closed when either of the other two rods are in the switchboard, the result would be that the current would run back into the gravity cells. The lever, *L*, should always be on 0 when the switch, *A*, is closed. The binding posts, *E* and *F*, are for use when the primary circuit is required, and the switch, *A*, is opened.

Where fresh dry cells are used, it is not necessary to connect the gravity battery until they become somewhat run down. Care should be taken in wiring the rods and the switchboard that none of the screws are too long, and touch.

Such an outfit as this requires only that the gravity battery be refilled when required, and will furnish when fully charged, and when rod No. 3 is in the switchboard, about sixty volts.

It takes some time to charge when thoroughly run down, but for a person only requiring current for a short time each day or so, it is ahead of anything I have tried.

Voltages of 12, 18, 42, and 51 may be had with this rod, by moving switch, *L*, over contacts 1, 2, 3, and 4.

* Specially prepared for the SCIENTIFIC AMERICAN SUPPLEMENT.

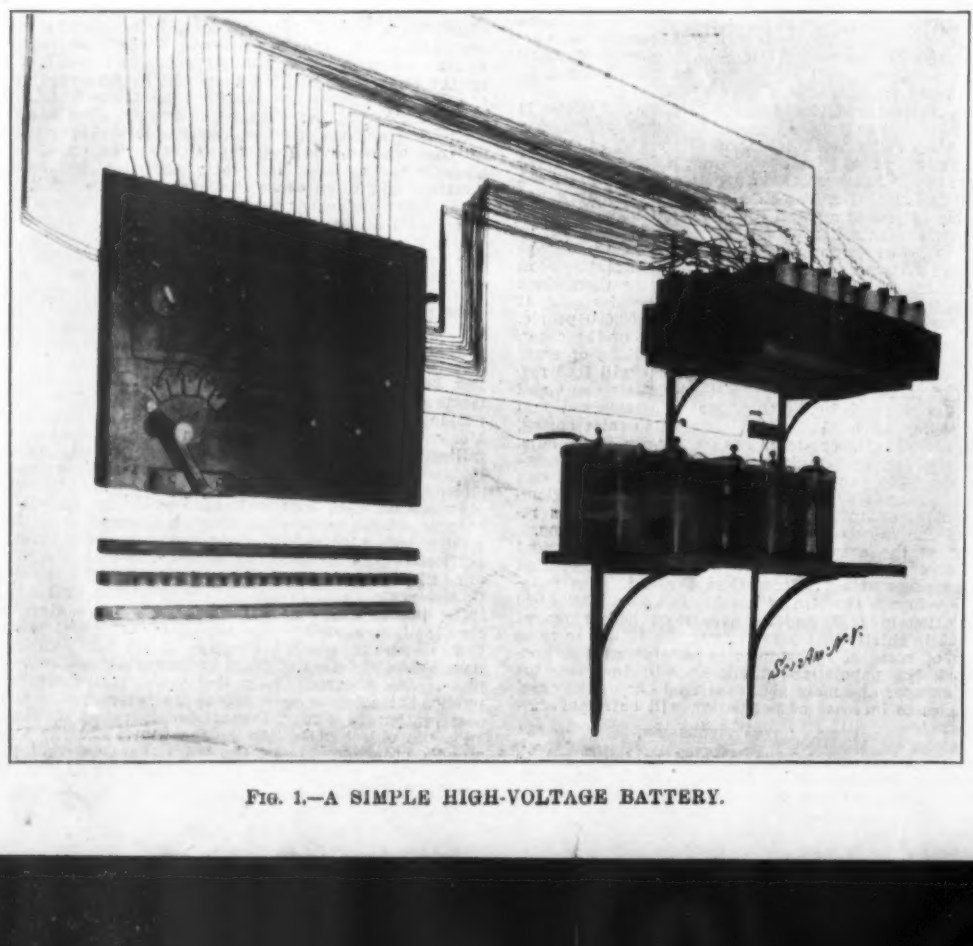


FIG. 1.—A SIMPLE HIGH-VOLTAGE BATTERY.

## THE EARTH AS A CONDENSER AND ITS RÔLE IN WIRELESS TELEGRAPHY.

IN the past, ideas relating to the earth as an electrical factor have been extremely vague. This is mostly due to the fact that the first step of the development of the science of electricity was the establishment of an elaborate mathematical theory of electrostatics, and it became customary to set the potential of the earth once for all equal to zero. As in practice we have to do only with differences of potential, it does not matter how we fix the absolute value of the potential and we may fix it by assuming the earth to be at zero potential; then the potential of any other body is determined by its potential difference with respect to earth. This assumption is unattackable as long as we restrict our considerations to the values of the potentials of all points of any system of bodies *at a given moment*. But this arbitrary assumption has led to the popular belief that whatever changes take place in the electrostatic configuration of a system above earth, they have no appreciable effect on the potential of the earth; and as the geometrical dimensions of the earth are so very big compared with those of any electrical apparatus in common use, it has been popularly assumed that the potential of the earth remains unaffected by mundane electrical disturbances. This assumption, however, would be right only if the earth's electrostatic capacity had an infinite value, and it is easy to show that this is not the case.

To find the capacity of the earth, we may apply the formula well known in ordinary electrostatics, for the potential of a charged globe. If a globe of a radius of $r$ cm. is charged with $e$ electrostatic c. g. s. units of electric quantity, then its potential in electrostatic c. g. s. units is the ratio of $e$ to $r$; hence the capacity of the globe, i. e., the ratio of charge to potential, is $r$. If measured in electrostatic c. g. s. units, the capacity of the earth is, therefore, equal to its radius in cm., i. e., about 637,000,000. In order to pass from electrostatic c. g. s. units to the practical unit of microfarads, we have to divide by 900,000, and thus find the capacity of the earth to be 708 microfarads. It will then be seen that its value is not at all infinite, compared with capacities which are used in practice.

Dr. A. Koepsel, a German electrical engineer, well known as the designer of some accurate measuring instruments, points out in an interesting article in Dingler's Polytechnisches Journal (June, 1903) that, in view of this comparatively small capacity of the earth, it is quite possible that the earth plays a very important rôle in wireless telegraphy; in fact, from his calculations it appears plausible that Marconi's celebrated ocean telegraphy was accomplished not by transmitting waves through the ether, but by setting the earth into resonance.

The question of the rôle which the earth plays in wireless telegraphy has often been discussed, and in Marconi's first experiments earthing of the receiver and transmitter was found to be necessary. Afterward in Braun's system earthing was avoided, and, moreover, it was found that wireless telegraphy was possible from balloons without earthing; these facts were then considered as a proof that the earth plays no important rôle in the transmission, and that the propagation of the waves should be considered as analogous to that of light waves. There remained, however, one principal difficulty, namely, the explanation of the fact that the waves used in wireless telegraphy do not seem to travel in a straightforward direction, but follow the curvature of the earth. The argument that the wave length of these waves is very large compared with those of light waves, does not fully overcome this difficulty. Moreover, Braun's apparatus may be considered as only apparently independent of the earth, because he uses appliances which are certainly in some relation to the earth.

Dr. Koepsel discusses this matter from a new point of view. We know that the length of the vertical wire used in every wireless telegraphy station is in a very close relation to the wave length of transmission, it being one-fourth of the wave length. Dr. Slaby's analogy with a tuning fork is very instructive. The tuning fork is at rest at one end and its vibrations are

a maximum at the other end; these two ends correspond to a loop and a node of the electric wave, and the distance between is one-quarter of a wave-length. The vertical wire in wireless telegraphy is connected to one pole of the spark-gap, while the other pole is usually earthed. Now, Dr. Koepsel puts the question in this way: Cannot this earthing wire, together with the earth, be brought into resonance with the whole system? In this case we would have both poles of the spark-gap connected with what the author calls two resonance wires, i. e., two sources of reactance and capacity. One resonance wire would be the vertical wire; the other resonance wire would be represented by the combination of earthing wire and earth. What Dr. Koepsel discusses mathematically is the question whether the electrostatic capacity of the earth, as above determined, has such a value that, together with the earthing wire, it can be made to represent a source of inductance and capacity corresponding to the condition of resonance.

If we again apply Slaby's analogy with the tuning fork, Koepsel's argument may perhaps become clearer. We usually place a tuning fork on a resonance box, and this box must be so designed that it is in acoustic resonance with the fork. The tuning fork corresponds to the vertical wire in wireless telegraphy; the resonance box corresponds to the earthing wire, together with the earth. If we can arrange our whole system of electric wave transmission in such a way that the earth acts like a resonance box, we have, of course, in the earth a powerful help. For the transmission of sound to a distance the resonance box is much more effective than the tuning fork; likewise, in wireless telegraphy over very long distances, the rôle of the earth may be much more effective than the ether waves transmitted from the vertical wire.

The problem which thus is placed before the designer is, however, different in both cases. In the one case the tuning fork is given and we design the resonance box so that it suits the conditions. In the case of wireless telegraphy the earth and its capacity are given. The earth, together with the earthing wire, corresponds to the resonance box; therefore, while we still are at liberty to choose the earthing wire at will, yet the main element of our electric resonance box, *i. e.*, the capacity of the earth, is fixed, and we must arrange our telegraph apparatus to suit the earth.

For the condition of resonance it is essential that the product of the self-inductance, $L$ (in henries), and the capacity, $C$ (in microfarads), of each "resonance wire" (as defined above) have a certain value. The earth and the earthing wire form one "resonance wire"; both together represent a certain set of values of $L$ and $C$, of which $C$ is determined by the fixed capacity of the earth. The product, $L\,C$, depends on the wave length used for the transmission. We are at liberty to choose the wave length of transmission and the self-inductance, $L$, of the earthing wire. We must choose both values so that $C$ then becomes the value of the capacity of the earth.

Dr. Koepsel solves this problem by a method of trial. He calculates tables for wave lengths of different values; for each wave length he has a given value of $L\,C$, which has to correspond to a combination of a wire and a globe. He assumes wire of 1 millimeter (0.04 inch) diameter and calculates for different lengths of the wire the size of the globe which must be added. He finds that the numerical value of the size of globe becomes more and more that of the earth, the larger the wave length and the smaller the self-inductance of the earthing wire.

We may assume that we use wires of 1 millimeter (0.04 inch) diameter. Dr. Koepsel proposes to make the small self-induction, $L$, equal to 0.0000001 henry. This is approximately the case if we use an earthing wire of 10 centimeter (4 inch) length. The value of the product, $L\,C$, is thus fixed and we find that if there shall be resonance, the wave length of transmission must be 10,000 meters (6.2 miles, or 10,900 yards). This would require a vertical wire of 2,500 meters (2,700 yards). Under these conditions the earth would be in resonance. The long vertical wire acts like a tuning fork, and the earth acts like a resonance box. We may now determine the exact value of the oscillations of the potential of the earth under these conditions.

The capacity of the vertical wire is 0.009 microfarad; that of the earth is 708 microfarads; hence the ratio of the two capacities is 0.000013. The potentials relate to each other inversely as the capacities. Hence if we assume the potential of the vertical wire as 100,000—which value can be obtained in practice—the potential variation of the earth would be $100{,}000 \times 0.000013 = 1.3$ volts. The electric quantity required for this purpose is 0.0009 coulomb. The maximum rush of current at minimum damping would not be over 15 amperes.

If a plurality of vertical wires is used, this value of the variation of the potential may be increased at will. By increasing the number of wires the capacity increases in a ratio different from that of the decrease of self-inductance. The resonance length is, therefore, decreased. If we design our vertical wires accordingly, the value of $L\,C$ is not changed, and nothing is changed with reference to the resonance of the earth. But as the capacity of the vertical wire system has increased, its ratio to the capacity of the earth has also increased; and from the calculation, given above, it will be seen that the potential variations of the earth are then also increased. If, for instance, 400 wires are used at a distance of about 0.5 meter (20 inches) from one another, then if the corresponding shortening of length is taken into account, the capacity of the vertical wire system would become about one-ninth microfarad; hence its ratio to the capacity of the earth would be 0.00016. If we assume again a potential of the vertical wire of 100,000 volts, the variations of the potential of the earth would be about 16 volts.

While Marconi in his apparatus for ocean telegraphy may not have reached complete resonance, as his wave length is still too short, it is probable that he comes near this condition. While the figures of Dr. Koepsel's calculations cannot be considered as absolutely exact on account of certain approximative assumptions, he believes that they are correct as to the order of magnitude.

An interesting conclusion drawn by the author is that if this theory is correct it should be possible to receive the signals without the use of a vertical wire at the receiving station, if the transmitting station be designed so as to set the earth into resonance. The author believes this to be possible even without a vertical wire at the transmitting station of the enormous height of 2,700 yards.—Electrical World and Engineer.

## THE OSSANT MUFFLER FOR GASOLINE ENGINES.

AT the last muffler competition organized by the Automobile Club of France, the silencer devised by the Ossant Brothers achieved great success. As is well known, the noise of explosions is due to the abrupt motion of the air produced both by the rapidity of the exhaust and the vibratory motions that are the consequence of the sudden cooling of the exhaust gases. Now, the Ossant muffler does away with such physical phenomena, on the one hand, by diminishing the rapidity of the exhaust, and, on the other, by abolishing the abrupt cooling of the gaseous exhaust current. The apparatus consists of a cylinder provided with interruptions and resistances, through which the current of gas is passed in order to diminish its velocity and, at the same time, to cool it. The muffler, in order to resist the high temperature of the current of gas, is formed of sheet iron tubes provided at one of their extremities with numerous small apertures serving for the passage of the gaseous mixture. The vibration of these tubes is prevented by doubling the walls and lining them with a mattress of asbestos.

The accompanying figures show the operation of the apparatus, which is represented in longitudinal section in Fig. 1 and in transverse section in Fig. 2. The muffler consists of a series of tubes, *A*, *B*, *C*, *D*, set one within another and provided respectively with a large number of small orifices, *a*, *b*, *c*, at one of their extremities in order both to permit and to somewhat retard the passage of the current of gas that enters through the center tube, *E*, in the direction shown by the arrows, *F*. This current, after reaching *A*, at the extremity of this same tube, passes through the orifices, *a*, into the tube, *B*, and thence through the orifices, *b*, into the tube, *C*, and thence through the orifices, *c*, into the tube, *D*, whence it escapes through the pipe, *G*, into the atmosphere.

The walls of the tubes, *B*, *C*, *D*, in all the parts unprovided with apertures are double. Between the layers of metal is placed a sheet of asbestos, *H*, designed to deaden the shocks of the current of gas against the metal. The bottoms of the different cylinders are closed by means of the same plate, *L*, *M*, having double walls with an interposed sheet of asbestos, *H*, and upon which are riveted angle-irons, *K*, that serve to maintain respectively the various cylinders, *A*, *B*, *C*. The heads *L*, *M*, are respectively riveted to the cylinder, *D*. As for the tube, *E*, that is soldered to a coupling plate, *E'*, which is fixed to another plate, *E''*, by means of bolts or otherwise.

Instead of causing the hot gas to enter at the center, as shown in the figures, it may be made to enter at the periphery into the tube, *D*, so that it may make its exit at the center through the tube, *A*. In this case, it is of importance to arrange at the extremity at which the gas enters a chamber upon which is mounted the external tube, *D*, in order that the gaseous mixture may, through such chamber, enter the entire section of the tube, *D*. The apparatus may, moreover, have any section whatever—circular, rectangular, or elliptical.—Translated from La France Automobile for the SCIENTIFIC AMERICAN SUPPLEMENT.

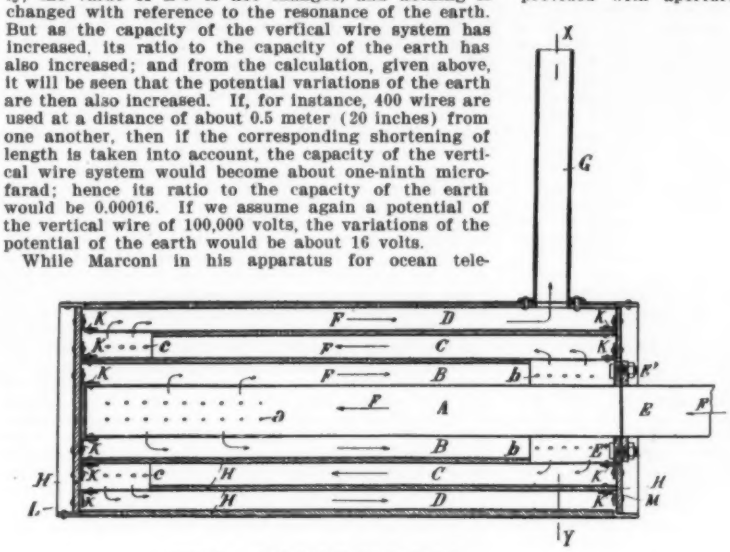



FIG. 1.—LONGITUDINAL SECTION.

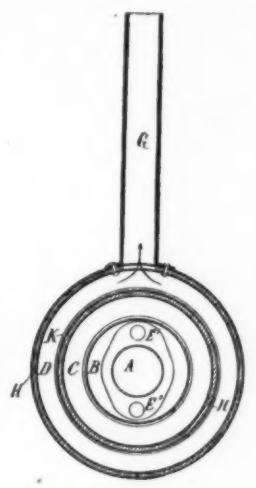



FIG. 2.—CROSS SECTION.

THE OSSANT MUFFLER.

## THE DUREY-SOHY STREET SPRINKLER.

VARIOUS types of street sprinklers have been devised, but the trouble with most of them has been that they required the use of too great a mechanical power, or else that they wet the street too profusely. We shall not enter into their history, but shall confine ourselves to a description of the most recent type of sprinkler, designed by M. Durey-Sohy, and experimented with at Paris, under satisfactory conditions, by M. Boreux, inspector-general of public works. The Durey-Sohy machine solves the problem of moistening instead of soaking, that is to say, of effecting the sprinkling by means of water brought to a state of very fine division. The atmosphere around the revolving brushes becomes saturated with a sort of mist which, in the fall of its particles upon the ground, unites and carries along the corpuscles, germs, and microbes that might have a tendency to rise in the air. The quantity of water employed for this purpose is relatively small. From the standpoint of cleaning, the essential part of the machine is a revolving brush (consisting of fibrous material) mounted upon a wooden cylinder provided with iron journals at its extremities. During the operation of sweeping, this brush rests upon

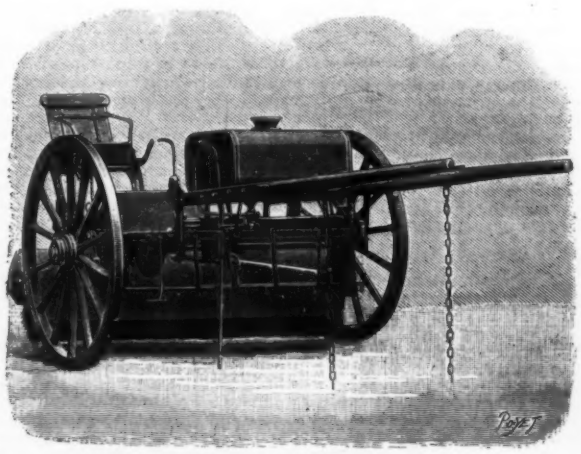


FIG. 1.—THE DUREY-SOHY STREET SPRINKLER.

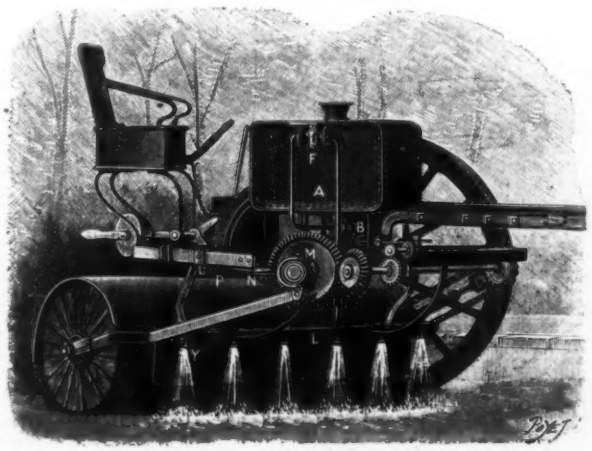



FIG. 2.—SIDE VIEW, SHOWING OPERATION.

A. Tank. F. Three-way cock. B. Pump. M. Clutch box. N. Gearing fork. P. Spring of the gearing. L. Sprinkling pipe, with atomizing orifices Y.

the ground and revolves in a direction opposite to that of the wheels of the machine. It is, moreover, inclined with respect to the axis of the latter so as to throw the mud to one side, while gearing with clutches permits of instantly starting or stopping the brush. The other mechanism lifts the brush when it is no longer being used. The driver controls these two motions by means of two levers placed within his reach, and he can also regulate the pressure of the brush upon the ground by means of a movable counterpoise.

The machine, as it is at present constructed, is drawn by a horse. The rotary motion of the brush is communicated by the axle, which revolves in bearings secured to a wrought-iron frame that carries all the mechanical parts. Two ratchets placed near the wheels control the revolution of the axle, but only when moving forward, so that the machine can be turned about without any trouble, each wheel being capable of describing the path proper to it, and the actuating of the axle during the turning about being effected by the outside wheel. By means of a pair of bevel gears the motion is transmitted to an intermediate shaft parallel with the brush, and is then transmitted by this shaft to the brush itself through an endless chain passing over two sprockets. The sprinkling, or rather moistening arrangement, is particularly well worked out. It consists of a pipe provided with atomizing orifices, fixed in front of the brush and parallel with it. It is from this pipe that the water, in the form of a fine spray or sort of mist, is projected against the ground. This water comes from a tank placed at the left of the driver. A small plunger pump sucks up the liquid and forces it into the sprinkling pipe under the pressure necessary for the atomization. The pump is actuated by a pinion that meshes with a gear on the intermediate shaft. A fine spray supervenes at the proper point, rendering sprinkling useless. The driver throws the pump into gear and the operation begins. Moreover, owing to a three-way valve, placed within the driver's reach, it is possible for him also, by sending the water from the pump to the tank instead of to the pipe, to arrest the sprinkling while the pump continues in operation.

In terminating this brief description it should be stated that M. Durey-Sohy has been able to make the motions of throwing the brush out of gear and of lifting it interdependent by means of a single lever, and with but a slight effort, so that the brush is always out of gear when it is raised and in gear when it is lowered. In this way, the wear of this somewhat costly part of the apparatus is prevented.—Translated from La Nature for the SCIENTIFIC AMERICAN SUPPLEMENT.

## FUNCTIONS OF TECHNICAL SCIENCE IN EDUCATION FOR BUSINESS AND THE PROFESSIONS.*

By ROBERT H. THURSTON, Sibley College, Cornell University.

". . . to write now the reforming of education . . . one of the greatest and noblest designs that can be thought on, and for the want whereof this nation perishes. . . . "—Milton, Tractate.

THE most remarkable and impressive movement of a period which has been well named the "wonderful century," was one which, from early and feeble beginnings, had been for generations slowly developing, and in rate of motion accelerating, until we to-day see it, in tremendous magnitude and power, affecting every department of human life. This movement causes progressive and cumulative changes in the methods and the products of the labors of the scholar and of the unskilled laborer, of the professional and of the mechanic, of the agriculturist and of the merchant; it changes the views and the studies of the historian, of the philosopher and the psychologist, of the business man and of the educator. It is the advance of the scientific spirit and method into all the fields of human learning and exertion. Scientific method is now dominant in all branches of human life.

This great change commenced with the earliest endeavors of thoughtful men to acquire knowledge by direct appeal to nature and experience. It acquired impetus as the experimental method and the spirit of research began sensibly to enrich our stores of learning and to yield their fine returns in the natural sciences. It assumed its firm grasp upon men's thought and controlled their work when invention and discovery and the upbuilding of new sciences impressed upon the minds of all sorts and conditions of men the fact that its methods were the only direct and sure ways to achievement. The methods are simple and even axiomatic in principle.

Science, *scientia*, is knowledge, and its significance became evident immediately it was seen that such an idea is the opposite of speculation, that the determination of a fact and its exact identification by suitable methods was the first step to further and exact knowledge of phenomena, and that this process and its result, the discovery of the laws governing facts in sequence, are the antipodes of the ancient method of primary appeal to the imagination, with later endeavor to find evidence sustaining the fairy tale thus evoked from the inner consciousness.

Wherever work is to be accomplished, the fact is the first requirement preliminary to action, and the controlling law is next to be discovered, in order that it, and every other agency of nature as well as of art, may be directed to the furtherance of the purpose held in view. The scientific method is as fundamental in education as in any other system of application of energy to useful result. A scientific training is an essential, a fundamental, element of all professional education, and systematic training, scientific training, is the direct way toward profitable acquisition and most prompt and complete success.

The scientific method is not restricted to the work of the distinctively so-called man of science. There is a scientific method in history, in the teaching of languages, in theology, or in philosophy, quite as definite as in mathematics, chemistry, or physics. There is a scientific method of education and of pedagogy. In all cases it simply means the co-ordination of the two essentials, knowledge, exact and definite, and sound reasoning, the exact acquaintance of the teacher with the fact to be taught, a distinct recognition and formulation of the principles and laws behind the system of facts and phenomena, and systematization of all contemporary knowledge of the subject in such manner as to permit the presentation of all in concise form, in logical order and in perfect symmetry. There is even a "scientific method of advancement of science."* as of every other department of human knowledge, even of the spiritual in humanity itself.

The mission of science, therefore, in the broadest sense, is the promotion of all human knowledge and, through the extension of learning and of culture, to give wisdom and to offer opportunity for its exercise.† Its direct product is material advance in the industrial system, providing increasing comfort and leisure for the people, and through this improvement in the lives of men, giving opportunity for the development of the intellect, the affections and the soul. But its highest task, though not a more essential element of progress, is the promotion of the efficiency of all our methods of preparing our youth for the "future of their lives," as Paley says, "to perform justly, skillfully and magnanimously, all the offices, both private and public, of peace and war," as Milton puts it in his specifications for a "complete and generous education." In every department such an education teaches first the facts, then the principles and formulated law, and next the system, and finally all practicable applications and illustrations and, where physical manipulations are involved, as in the laboratories, in the gymnasium, in the military academy or in the applications of science in the industrial arts, the utilization by the practitioner of the system thus established. In abstract learning, the principles and the methods of science, as of philosophy, of history, of grammar and philology, are practically applied in the acquirement of further knowledge by the educator and the investigator, and in securing and in maintaining full possession of that learning by the scholar.‡

A "technical education" must be defined before it can be intelligently discussed, and in this discussion it will be understood that by a technical education is meant one that will most effectively prepare the individual to become competent, after experience has had its ripening effect, "to perform justly, skillfully, and magnanimously, all the offices" appertaining to his vocation. His business in life may be commerce or a profession, trade or transportation, education or theology; in each and all, there is a certain essential foundation of exact knowledge, a certain system of principles assuring stability and characteristic form, and another desirable but less absolutely essential quantity of accessory and incidental information and general education and "culture," which is needed to give the man that finish and perfection of fitting for the intercourse of man with man which, while not vocational or professional, is none the less an element of real and highest success.

Proceeding to consider the circumstances which determine the form and extent of the technical education of the citizen, the relation of such education to the whole system of preparation by special training for life's special work, it is first necessary to agree upon a definition of the terms technics, technical, technological. The Greek, from which the terms originally come, in the primary and the broadest sense regards these terms as relating to the arts, both esthetic and industrial, and the technique of the artist, of the musician, of the watchmaker and of the steam-engine builder, in each case, infers special talent or special acts appropriate particularly to the art. Technical education, therefore, is a system of instruction devoted to the development of a knowledge of an art, as, for example, taught in a school of music, of law or medicine, of engineering, of theology, or of any industrial department.

Huxley says: Technical education "means that sort of education which is specially adapted to the needs of men whose business in life it is to pursue some kind of handicraft;" but this definition is obviously narrow. Technical education is admitted to include engineering, for example, which demands a most extensive and most intense preparation, and involves as large an amount of learning, especially in both pure and applied science, as any other vocation—as much as is demanded in the other schools of the "learned professions," once distinctively so called. The technical educations include all the educations which fit the man for "the sequel of his life," as a member of a working community. But any business career is chosen as a means to an end, and that end should always be the attainment of a competence to insure comfort in old age, and meantime a comfortable life from youth to age, and the privilege of seizing all opportunities for moral and intellectual growth and for becoming of some use in the world. The business education must, therefore, be accompanied by a general education such as will do most to fit the scholar for his place in the social world, and to take advantage of those opportunities which come to all energetic men and women in a country such as ours.

Fortunately, these requirements do not usually conflict or result in inefficiency of either branch of work. The opportunities which are opened to the average citizen, or to genius, even, in this country, apart from those of the vocation, may be usually seized by any one having the requisite intelligence, ambition, and vigor, if possessed of a good common-school education. If such a person needs more, his common-school training will have set him at the beginning of the path, at least, and will have fitted him to move forward, not as easily and rapidly as if under expert instruction, but, as experience has shown in many cases, so as to attain the object of the ambition of the moment. Fortunately, also, whatever the ultimate aim, the beginnings of education must be those which supply the tools with which to construct a career. The education of the primary, and, in large part, of the secondary school is a preparation for the whole sequence of life, whatever that sequence may become. The arts of reading, writing and computation underlie all arts and all vocations and professions. The languages are the entrance ways to all the literatures. All persons, whatever their aims, must begin by learning the curriculum of the primary school and must usually go on through that of the secondary school. This is, necessarily, all of the nature of education, as distinguished from technical training. Technical science can not be taught effectively, even where essential to the plans and the future of the individual, until a considerable amount of general knowledge has been acquired and the beginnings, at least, of a liberal education supplied. The beginnings being thus acquired, the ambitious man or woman will find ways of supplementing it; the unambitious will forget what has been already gained.

The place for the beginnings in the teaching of technical science, applied science, science in its applications to business, is evidently at the point where the scholar commences his formal preparation for a business life. Yet it is generally the fact that something should be done in this direction in advance of the actual beginning of the business-school work. There is a certain amount of scientific instruction and something of technical, or applied, science needed by all, whether the future is to be a life of scholarly leisure or one of strenuous endeavor in whatever department of industry. Such sciences are, for example, physics and chemistry. These should be taught in the general course, irrespective of the plans of the scholar for the future of his life. Certain sciences, also—botany, for example—have interest for all and are essential parts of the education of the man whose vocation is to be that of the scholar, as well as of the technical training of the naturalist. These classes of subjects are, or should be, taught as electives when the curriculum becomes easy of enlargement in that manner, after the pressure for necessary primary instruction has been relieved. Thus, through all the earlier stages of the education of the citizen, the curriculum is mainly a fixed one, given form by necessity. Time must be devoted to those studies which the child first and most needs as preliminary to all the later education and life. As these are acquired, opportunity gradually reveals itself for the introduction of special and elective courses to be distributed to the pupils in compliance with the demands of their prospective business lives.

At the beginning of this latter period, the place of technical education and of the teaching of technical science comes into view. As the pupil becomes older and his plans for life more definite, the extent and character of the technical science to be taught him become more obvious and more completely known. But the desirable course is now to transfer him to the school of his trade, or to that which most nearly supplies its place, where expert instruction in every department may contribute with maximum efficiency to the proposed end. If the "business" to be pursued is commercial, it would seem that the youth should remain in the academic schools just as long as time and money and natural capacity permit, and then he should take up the work of the business or the commercial school. The sciences taught, meantime, in the academic public schools should evidently usually be those which may fairly be assigned to a general course, as being valuable to all citizens. Specialization implied by technical science should be deferred as long as practicable.

When the vocation or the profession is finally chosen, the pupil will demand preparation for the technical or the professional school, and, where the demand is sufficiently large to justify it, special arrangements, if necessary, should be made for meeting its requirements. This may mean the establishment of electives for pupils preparing for the academic college, the law-school or the school of engineering. It may mean some substitution of scientific for the usual educational courses where the latter may be safely thus displaced. Those requirements determine the nature and extent of the scientific and of the technical instruction to be introduced. Where the pupil is to go directly into business and his precise line of work is not settled, or where it is evident that he is of that class, large in this country, liable to pass from one vocation to another, the technical sciences of the curriculum should be, in general, the mathematics and the sciences of physics and, particularly, of chemistry. The constant endeavor of our school boards and committees to crowd the whole pantology of an extensive liberal education into a common-school system can never succeed, and the attempt only embarrasses and renders inefficient the work actually squeezed in. If the school is large enough, as often in the cities, it may be practicable to arrange a system of electives, as is done in the colleges, wherever it appears that a sufficient number may be classed together to compensate the specialist to be employed as teacher. In smaller schools this course is usually impracticable.

Education for a vocation being the leading object of any school, its curriculum properly involves mainly those subjects which contribute especially and directly to, and are essential to, its purpose. General education has no place, as such, here, and the student should clearly understand that his education, in the ordinary sense of the term, should be obtained, and as fully and as liberally as practicable, elsewhere, and usually previously to taking up the scholastic apprenticeship. The curriculum of the school should include the essential studies, the sciences and the technical information regarding materials and products, processes and apparatus, which contribute to accurate and efficient work and to economical production. There is always a certain sequence which is entirely logical and which settles all questions of order in taking up the various subjects, and this problem is usually non-existent in the technical school. Thus the mathematics must be taken in a fixed order; the applied science must follow the study of the pure science; and physical and chemical and mechanical work must be given after the mathematics have been more or less completely mastered; for, in the technical school, these sciences are quanti-

* An address at the dedication of Engineering Hall, Iowa State College, May 29, 1903.

* "The Scientific Method of Science Advancement," vice-president's address, American Association for the Advancement of Science, St. Louis meeting, 1878. R. H. Thurston.

† "The Mission of Science," vice-president's address, American Association for the Advancement of Science, Philadelphia meeting, 1884. R. H. Thurston.

‡ "The Miltonian Teaching." An address delivered at Pratt Institute, Brooklyn, December 11, 1894.

tative and involve mathematical processes. In this assignment there is no question of the place of these sciences in the work, as the object to be attained fixes all requirements.

The sciences are all, ultimately and necessarily, taught as applied sciences. There is no time, and no needless expenditure can be made, for the acquisition of abstract knowledge when so much is to be learned which is to be utilized directly. It is thus essential to complete success that the teacher be entirely familiar, as an expert, with the applied science. Experience shows that, in the engineering colleges and schools, thoroughly satisfactory work in the sciences is best insured by the selection, as teachers, of talented and interested scientific men who have given sufficient time to the business for which it is proposed to fit the student to become practically familiar with it and with its applications of his science. The pure sciences are as necessarily also best taught by experts, and this means those who have specialized in the sciences commonly taught in the academic departments of our schools and colleges. In fact, the rule that teaching should not be permitted to amateurs, in any branch, least of all in technical departments, should be made universal.

The curriculum should be as obviously constructed by experts in the business to which the school acts as feeder. Only the expert in the business can say what branches of instruction properly constitute the technical plan of instruction. The determination of the character and extent of the technical work in turn settles the question, What sciences and what general instruction must be supplied as a basis for the technical work? The form of the whole scheme of instruction being thus completely fixed, the details should be assigned to specialists, so far as practicable; each to be familiar as an expert with the work demanded of him.

Every business, even purely commercial, involves some connection with the producing industries, and the commercial man should evidently, in each case, have sufficient familiarity with the industry to be able to buy and sell intelligently and to discuss details involving financial interests with his correspondent.

It would seem that, in the individual case, only the student himself can say precisely what kind and approximately what extent of scientific and technical instruction is required of him. The technical school should be prepared to meet the demands of as large a variety of business interests as practicable, after sufficient experience has been had to permit decision. Probably some knowledge of mathematics, chemistry and physics will prove useful to all. Those intending to go into lines of business connected with the iron and steel industries will demand some instruction in the chemistry of metallurgy; those expecting to deal in products of the machine-making arts will need instruction in applied mechanics and machine-design; those about to enter upon commercial work relating to transportation will need some knowledge of the principles of conduct of shipment and construction of invoices.

The whole case, so far as relates to curriculum building, may be put in a few words, thus: The practitioner in the vocation, professional or other, for which educational apprenticeship is to be provided, should decide what sort and how much technical instruction is needed at entrance into that branch of industry. This schedule of required work should be assigned to experts in each of its divisions, to those who have practical and expert knowledge of the business. The requirements being thus ascertained, the next step is to provide for such studies and such tuition as are needed to prepare the student for beginning the prescribed studies. These being introduced, the next lower stratum of subjects is laid out as introductory to the preceding, and this process is continued until a curriculum is constructed which, leading up out of the common schools, terminates at its superior limit at that point at which the diploma of the technical school or college becomes a sufficient guarantee of satisfactory preparations to enter the business and to perfect the professional education by the regular practice of the vocation chosen.

The final form and extent of this curriculum must necessarily be determined by experience, and the preliminary outline must be accepted as provisional. The curriculum will be subject to constant change, amplification and improvement in detail, as time and the forward progress of the profession or the business permits or compels, and thus the adjustment of the work to the requirements becomes more and more perfect. Ultimately, the practitioner will find that the institution is doing all that can be fairly asked of it, and the novice entering into business will find himself as well outfitted as is possible in the time and at the expense permissible, and the youth proposing to take up the line of work in view will find his progress out of the common school into the business school or college, and out of the latter into business, a smooth and continuous and clearly defined movement. Once in business, thus prepared, his success will depend upon his own talent, industry, tact, and judgment.

This development of our system of general education is the great work of our day and generation. The wisdom of our statesmen as well as of our educators is to be tested, and is being measured by the promptness and effectiveness with which they adapt their own ideas, and fit the educational system, to the requirements of a modern industrial organization. When they stolidly follow the ways of the ancients, modern life flows past them. Modern educations illustrate the wisdom, the learning, the knowledge and the culture of later centuries The wonderful gains of the nineteenth century, particularly, are being supplemented by those who have the wisdom of great statesmen, the learning of modern times, the knowledge which science supplies and the culture which comes of a symmetrical education in all the arts, the sciences, the literatures and the philosophies of our own time, so far as it has been permitted to incorporate them into school and college curriculums. The extraordinary work of the German empire had its origin, in fact, with statesmen who, without being themselves familiar with the scientific curriculum, were wise enough to understand its fundamental importance and to know its place in the modern educations and the social system.

The nineteenth century has been called the wonderful century; but the world has, since the commencement of the seventeenth century, at least, been progressing with swift acceleration, and each century has been wonderful and each more wonderful than the last, to the contemporary looker-on. The twentieth century is probably to be more wonderful than the nineteenth, not perhaps in the fact of its seeing the inauguration of a new era in science and the arts, that is a wonder, unique and probably without precedent or later rival; but it will no doubt bring its share of new wonders and of new achievement, opening new realms of nature, utilizing new forces and energies, and availing itself of the old in new and unanticipated and marvelous ways. New elements and new compounds are to be discovered having more remarkable and more useful properties than the old; new methods of manifestation of that protean power which we call energy will be observed and utilized in forwarding the tasks of the engineer and strange and mysterious phenomena now puzzling all philosophers, "natural" or other, will find interpretation and application to good works for the benefit of mankind.

In all this the young men now coming into their opportunities, and their successors of the next generations, will have their part and find their opportunity. The progress of the world is still an acceleration, and the gain and the opportunity acquire magnitude as a rapidly increasing function of the elapsing time. The work of the educator assumes constantly higher value and greater importance and commands more respect and larger distinction. The place of the engineer in the world, lofty as it has been in earlier days, when Archimedes and Leonardo and Watt and Fulton and Morse pointed the way to advancement through the union of the sciences and the arts, and high as it is to-day, when its apprentices are coming forward with the learning of the centuries at their command and the skill of the modern mechanic and inventor and the productive power of all modern machinery at their will; it must grow with the advances of the new industrial world until it shall become one which old-world, old-time kings may well, and in vain, aspire to hold. The engineer must be the general of the industrial army and in his hands be held the fortunes of nations. Those who to-day witness the foundation or the dedication of a noble structure, appropriated to the work of contributing to the education and the professional training and apprenticeship of the young engineer, are witnesses of an event contributing to the highest welfare of the race. Those so fortunate as to be of the generation entering upon this work with the commencement of the new century have the splendid privilege of taking just as large a part in the growing opportunity of the engineer and his army as their wisdom, talent, ambition, and energy may permit them to assume. The man, to-day, who has the wit to recognize opportunity and the skill and ability to take advantage of it may fairly expect to go as far and to rise as high as he may choose—always provided he maintains himself in a condition of mental and moral and physical efficiency. For he must make himself a part of the great machine and keep time with its march, and maintain what I am accustomed to call "maximum commercial efficiency."

Perhaps, in this day and generation, nothing can more effectively contribute to the weal of the nation than the institution of efficient means of promotion of the work of the engineer and of his profession. As chief of the industrial army of producers of permanent wealth, his wisdom, his knowledge, his culture, and his professional efficiency, as derived by the application of talent and wisdom to the improvement of the apparatus and the methods of production, constitute the primary elements of material progress and, through material gain, of the advancement of the nation and of the race.

The progress of the state, in all directions, is largely influenced by the statesmanship of the people of the state, through the legislation of the representatives of the people in investing available capital in the cultivation of the applied sciences and the encouragement of the universality, the continuity, and the efficiency of the industrial system. A people which is thus made in maximum degree industrious, skillful, fruitful, through the exercise of every talent in the most diversified employments, and capable of thus making the industries in highest degree effective in supplying all the needs of the most enlightened community, attains most promptly and completely the highest position in the scale of civilization.

This end can only be secured by systematic and thorough education, not only in the departments of culture, but also of economic production, including, it should be understood, apprenticeship in the professions and the trades. In no department is this more essential than in engineering, where the sciences of mathematics, of physics and chemistry and of construction find their most important uses, and where a perfected economic system must find its directing minds.

This is also quite as true where the interests of the agricultural classes are involved. This intimate relation of engineering and agriculture comes of two principal requirements. First: The energies and the skill and the talents of the people should be so applied in agriculture that the energy of that industry shall be in minimum proportion given to that form of production which directs its powers toward the provision of articles for necessary but, nevertheless, in an economic sense, wasteful expenditure. The products of agriculture are intended to be destroyed, and the less this production of ephemeral forms of product compels a diversion into the work of providing the needed food-products, the larger the proportion of the producing power of the nation to be directed toward the production of permanent forms of wealth. Secondly: The more efficient this thus increased proportion of the producing power of a people can be made, the larger the accumulation and the more rapid the growth of wealth in the community, in its most permanent forms.

Already agriculture is a branch of mechanical engineering.

(To be continued.)

## ANGLO-SAXON MEDICINE.*

By JOSEPH FRANK PAYNE, M.D.Oxon.

BESIDES their native herbal medicines and the more scientific therapeutics and pathology which they had borrowed from the Greeks the Anglo-Saxons made a large use of charms and what are called magical rites in the treatment of disease. It would be a mistake to suppose, as is sometimes thought, that this was their only or chief method of treatment or that it was in any way peculiar to the Anglo-Saxons. A great deal of it was taken from the later Greek and Latin medical writers who show a credulity and superstition quite equal to that of the Anglo-Saxons. Again, the magical and superstitious medicine lasted much longer than the Anglo-Saxon period. It went on all through the Middle Ages up to recent times and is not extinct even at the present day. But it is by no means characteristic of our own country. Indeed, the numerous collections of "folk-lore," or what is called "folk medicine," from the peasantry of continental countries show that these ancient superstitions are more prevalent and more inveterate among them than they are among our own people. What is most remarkable is not only that the same general beliefs have survived but that the very same forms of words have in many cases been preserved for centuries and may be even now recited in certain places.

It is very difficult to define precisely what is meant by magical medicine or what by charms. But, broadly, they imply a belief in some supernatural efficacy belonging to verbal formulæ, recited or written, in special circumstances or with reference to special objects. Originally it would seem that this belief implied also the belief in spirits, demons, or some supernatural beings who could be either conciliated or coerced by the use of certain words. The belief in supernatural personages gradually waned and in the case we are now considering heathen or mystical conjurations were to a large extent replaced by Christian prayers and benedictions, while the occult rites of unknown origin were superseded by the services of the church.

Without pretending to a complete classification the various magical processes and charms may be brought under the following heads: 1. Prayers or invocations addressed to medicinal herbs or to supernatural beings supposed to have power over them. 2. Special verbal formulæ or observances employed in collecting the medicinal herbs or other natural remedies. 3. Prayers and mystical words repeated over the patient or written and applied to some parts of his body, with or without ordinary remedies. Such words are very often in a foreign tongue unknown to those who use them, such as Latin among the barbarous or uneducated, Greek or Hebrew among the Latins, and so on, sometimes in a quite unknown language, which have been called Ephesian charms. But they may also be in the vernacular. 4. Direct conjurations or exorcisms addressed to diseases as if they were evil spirits. 5. Narrative charms—that is, trivial stories relating to sacred or legendary persons who suffered from or did something analogous to what the patient is suffering from. 6. Material magic—that is, the attribution of magical power to certain objects, such as plants or parts of animals, stones, or engraved gems called amulets, these objects being not used medicinally but applied in some way to the patient's body. 7. Transference of disease by a magical formula or ceremony, to some animal or material object or in some way to the outside world. Examples of all these can be found in older medical literature as well as in the Anglo-Saxon books and also throughout succeeding centuries.

The actual origin of these beliefs and practices is extremely obscure and cannot here be considered. Doubtless there was an element of traditional popular belief in each particular country and also, as regards European medicine, an introduction of Oriental superstitions. But they formed no part of the regular classical medicine of the Greeks and Romans till the period of its decline. Hippocrates, Galen, Aretæus, and Celsus are entirely free from such superstitions. The first Greek medical writer of any repute who introduced the incantations into the practice of medicine was Alexander Trallianus, who has been already referred to as having been a great authority with the Anglo-Saxon leeches. Alexander has been blamed, and justly, for thus lowering the character of Greek medicine. He was, however, followed in this by later Greek physicians and by those late Latin writers to whom the Anglo-Saxons were much indebted. The Latin work of Marcellus Empiricus, older than Alexander, which appears to be partly founded on Roman popular medicine or folk-lore, was the great repertory of superstitious rites and formulæ.

On examining the Anglo-Saxon charms a considerable number are found to be directly taken from, or founded on, passages in the late Latin writers; a few are suggestive of passages in the Greek physicians. From all these sources it is easy to find examples of the various kinds of magical medicine above spoken of.

1. The invocation of herbs is found in Alexander Trallianus. For instance, he recommends as a remedy for gout that the sacred herb *hyoscyamus*, or henbane, should be dug up with certain precautions and addressed as follows: "Sacred Herb! I summon thee to the house [of my patient] to stop the rheum of his feet," etc.; "I conjure thee by the great name Jaoth Sabaoth." The Anglo-Saxons did not use prayers addressed to the herbs themselves, as benedictions and Christian prayers addressed to God or the saints were often substituted. But there are instances of certain formulæ of conjuration. For instance, the herb mugwort (artemisia) had the reputation of preventing a man who carried it with him from getting tired on a journey. But it was to be gathered before sunrise with these words: "*Tollam te, Artemisia, ne lassus sim in via.*"

2. Special words and mysterious rites were often made use of in gathering medicinal herbs to give them special virtue. The formulæ used by the Greeks and Romans being generally heathenish, the Anglo-Saxons often substituted Christian prayers. For instance, for gathering celandine the directions are: "Delve round the root and take it up with thy two hands turned up-

* Abstract of the FitzPatrick Lecture.

ward, and sing over it nine paternosters, and in the ninth, at the words 'Deliver us from evil,' snap it up," etc. There are also some very remarkable Anglo-Saxon "lays"—poems celebrating the virtues of herbs. In one of them Wodan is referred to, showing that it must have originated in heathen times. In many of the directions for gathering herbs the essential thing was *to name the sick man and his father.* This was a popular belief among the Romans, as quoted by Pliny. For the old ceremonies the Anglo-Saxons often substituted prayers and litanies. Thus before gathering certain herbs litanies of the saints and the paternoster were to be sung in church. Then the clergy or choir were to go three times round the herbs intended to be gathered, singing the same. The herbs were to be brought into the church with the same song and twelve masses sung over them in honor of the twelve apostles. Then they could be used.

3. The most important part of magical medicine consisted in mystical formulæ, conjurations, and prayers either uttered over the patient or written out and in some way applied to his body. Many, or perhaps all, were, it would seem, originally meant to be sung, as shown by the words "carmen" and "incantamentum." These were well known among the Greeks and many instances might be quoted from the poets of wounds being healed by the use of magical words. Alexander Trallianus recommends for the gout that a certain verse of Homer (Iliad II., 95) should be written on a gold leaf while the moon was in the sign of Libra, wrapped up and applied, presumably to the patient's joints. Why this particular verse was chosen does not appear; it would not seem specially appropriate.

The Anglo-Saxon charms were mostly in Latin, sometimes with corrupted Greek or possibly Hebrew words. One charm is described in the book as Scottish, but according to the editor the words belong to no known language. On the other hand, in another case, the apparently unintelligible words turn out to be corrupt Irish. In some the words seem to be without doubt mere rhyming or jingling nonsense—as, for instance, "*Gonomil, orgomil, marbumil,*" etc.—words which were to be sung into the *right* ear of a man but the *left* ear of a woman in case he or she had swallowed a worm in drinking water. The use of such charms was often combined with the use of drugs. In one prescription a drink made of twelve herbs over which seven masses had been sung was to be drunk out of a church bell with the accompaniment of singing certain psalms. Also the mass priest was to sing a formula of benediction over the patient. This was for a "fiend-sick" man—that is, a demoniac or lunatic. Sometimes charms were written on the "holy dish," or sacramental paten, and washed off with holy water which was to be drunk.

4. Exorcisms addressed to diseases as evil spirits are not common. An example is a charm for a strange "swelling." The sufferer was to sing a paternoster, to draw a line round the sore, and to say, "*Fuge diabolus! Christus te sequitur.*" There is an elaborate charm against agues and fevers in which they are adjured in the name of Christ to depart. A form of words against "poccas"—that is, small-pox—is remarkable because this word is taken as the equivalent of variola. Many formulæ of this kind are found in late Latin writers.

5. Narrative Charms.—This class of charms was used by the late Romans—for instance, by Marcellus Empiricus and probably in still earlier times. In the Anglo-Saxon books they are always scriptural stories or else Christian legends. One of the most extraordinary, or most absurd, is against toothache. It relates how when Christ was sitting with His disciples Peter looked sad and when our Lord inquired the cause he complained of toothache, whereupon Christ uttered a long adjuration addressed to migraine or other pains not to harm the servant of God. This was, of course, to be repeated. The story of Longimus, the traditional name of the centurion who pierced the side of Christ upon the cross, was told in order to take away a stitch in the side. To hasten child-birth the story of the raising of Lazarus with the solemn words, "Lazarus, come forth!" was thought to be efficacious. All these narratives and others like them were used not only by the Anglo-Saxons but frequently in the Middle Ages.

6. Amulets Derived from Natural Objects.—As a preservative from fits a fox was to be caught, its canine tooth knocked out while it was alive, and the animal then set free. The tooth was then to be wrapped in a fawn skin and carried on the body. The eyes of a crab removed from the living animal were good for affections of the eye if hung round the neck. In all cases the animal was to be kept alive. For headache certain herbs were to be bound on the head with a red fillet. There are many similar prescriptions in Alexander Trallianus and Marcellus Empiricus.

7. Transference of Disease.—It is a common belief in many parts of the world that disease is something which can be got out of the sick man and transferred to something outside. The Anglo-Saxons had mysterious rites, sometimes combined with forms of words, for this purpose. Often the disease was transferred to running water. Thus for a certain skin disease it is ordered to *score* or to scarify the neck after the setting of the sun, to pour the blood silently into running water, to spit three times, and to say, "Have you this evil and depart away with it." Or, again, a hazel or elder stick was to be taken, a name written upon it, and stained with blood. Then it was to be thrown over the shoulders or between the thighs into running water. In another case an oaken stick was to be stained with blood, then four strokes were to be made with it toward the four quarters of heaven. Then it was to be thrown away and a certain charm was to be recited. This was a charm against "flying venom," or in modern phrase, air-borne contagion.

Later Books of Anglo-Saxon Medicine.—One book contained in the three volumes of "Leechdoms" differs a good deal from the rest. It is that which bears a Greek title *Περὶ Διδαξεων*, interpreted as meaning "Of Schools of Medicine." This title only refers to the first chapter of the work. The rest consists of a collection of medical recipes differing from those in the other books of the Anglo-Saxon library. It is entirely free from charms and superstitions and the prescriptions are for the most part simpler than those of the Anglo-Saxon leeches. This treatise has been shown by a German philologist, Dr. Max Löweneck, to be based upon a Latin work belonging to the first period of the school of Salerno—viz., the Practica of Petroncellus or Petronius—a work written probably about A. D. 1035 and printed in the "Collectio Salernitana." One fragment has been traced to the writings of another Salernitan teacher, Gariopontus, of the same period. But these identifications do not account for the whole of the Anglo-Saxon text, and it does not seem that this was translated directly from the Latin. The actual origin of the work is therefore still somewhat obscure. The date of this manuscript is the first half of the twelfth century, probably before 1150. It shows that the Anglo-Saxons were beginning to profit by the teaching of the school of Salerno before that school was influenced by the Arabian medicine. It also shows that the Anglo-Saxon medicine, like the other written literature of that language, went on for some time after the Norman Conquest. To this same period belongs another manuscript which contains a version of the Herbarium of Apuleius later than that previously spoken of. This is not included in the Rev. O. Cockayne's "Leechdoms" but has been published in Germany, as edited by Herr Berberich. This manuscript is referred to the middle of the twelfth century, about 1150. It therefore touches on the extreme limit of Anglo-Saxon written literature, and, indeed, is called by Herr Berberich "Early Middle English;" but, like the last-mentioned work, it shows the long continuance of Anglo-Saxon medicine after the conquest. This work closes the early English medical library, and as the celebrated Anglo-Saxon Chronicle came to an end in 1150 the general literature and medical literature of our early ancestors reached their limit about the same time.

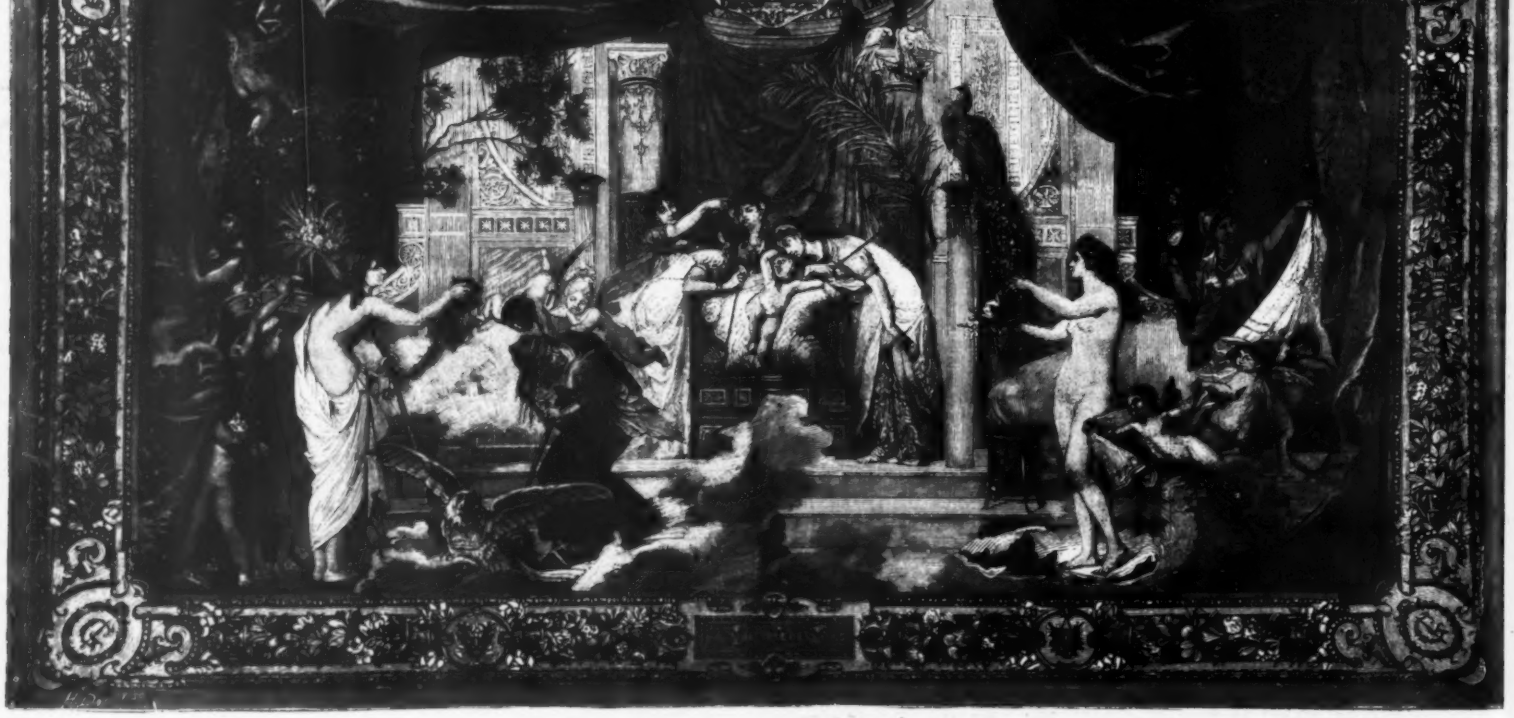
## A HANDSOME TAPESTRY.

THE example of tapestry which we illustrate is a particularly handsome one. Our engraving is taken from a French contemporary.

## A BALLOON TRIP OVER THE ALPS.*

A REMARKABLE balloon trip over the Alps was lately made by the well-known aeronaut Capt. Spelterini in his balloon the "Stella," accompanied by a party of aeronauts and scientists, among others Dr. Hermann Seiler. This feat is of great interest from many points of view, both on account of the high altitudes which were reached in passing over the mountain peaks and also for the different meteorological and other data which were obtained and will be published later. The party were well equipped with scientific and photographic apparatus. Dr. Seiler gave the following account of the voyage to our correspondent:

The balloon rose from Zermatt at 1:30 P. M. and mounted very rapidly up to an altitude of 9,100 feet. It approached the peak of the Mettelhorn (11,080 feet high), and came so near as to almost touch it. From this point a current of air drove the balloon in the neighborhood of the Weisshorn (14,670 feet high) where it rose to 10,500 feet altitude and soon exceeded this height in its movement toward the Dome des Mischabel. The balloon now took a direction at right angles to its former course. The wind was not very strong, so that it was only between 2 and 3 o'clock that the balloon commenced to change its course. It continued to mount progressively and traversed the northern extremity of the Mischabel, between Randa and Herbrigen; it then took a somewhat southerly direction, crossed the valley of the Saas, and at 16,000 feet altitude it crossed the Weissmies (13,100 feet high). From this point the balloon directed its course toward the north Italian lakes. During this trajet the aeronauts enjoyed the magnificent panorama of the Alps which presented itself to their view, and took a number of photographs. Near Weissmies they attained the maximum altitude of 17,200 feet and rose above the clouds, which are denser here than on the side next to Zermatt. Most of the mountain peaks were now hidden from view, but they could perceive the summits of the Bernese Alps, which rose above the clouds far in the horizon. The balloon now descended slowly and a mist enveloped the aeronauts. Before 4 o'clock they approached the Lago Maggiore and the immense extent of the Italian plain presented itself to their view. The contrast which was offered between the grandiose mountain scenery and the plain made an impressive spectacle, and Dr. Seiler states

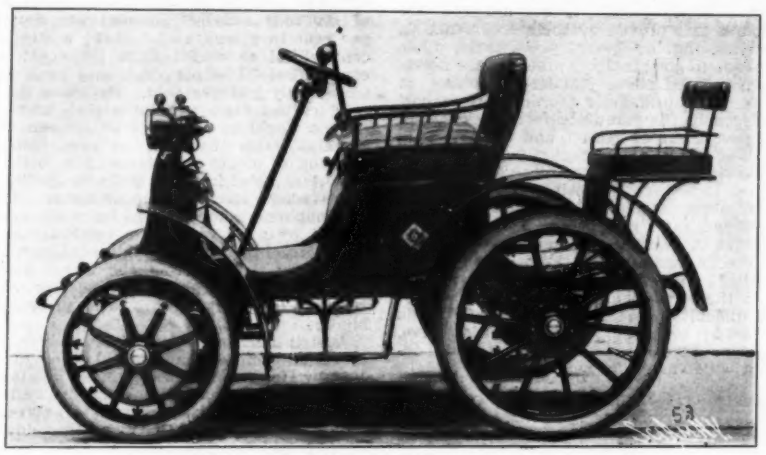


A HANDSOME TAPESTRY

* Specially prepared for the SCIENTIFIC AMERICAN SUPPLEMENT.

that it is the most wonderful sight that he ever witnessed.

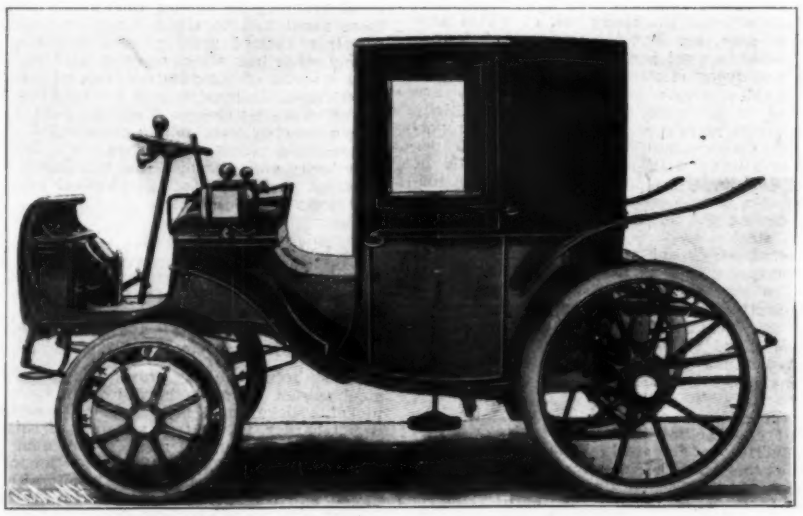
At 4.15 the "Stella" sailed along at 8,400 feet altitude over the Lago Maggiore, above Pallanza. It followed the middle of the lake as far as Pino and continued to descend near the water. A lake steamer which was passing to Brissago offered to tow the balloon, and had already begun to attach the trail-rope on deck. But after a short consultation the aeronauts decided to mount again, and after throwing out several bags



LOHNER-PORSCHE ELECTRIC AUTOMOBILE.

of ballast the balloon commenced to rise rapidly. It was now 7 o'clock in the evening and night was rapidly approaching. The balloon took a northerly direction after leaving Locarno, then came eastward and followed the valley of Maggia. It was now completely dark. Without knowing just where they were, the aeronauts sailed along in the direction of the wind, which was rather low. Near midnight they came above Prato at the head of the valley, and remained there nearly motionless at 12,700 feet altitude and just above the rocky heights which were touched at times by the trail-rope. Capt. Spelterini hoped that a breeze would send them in the region of Biasca, where it would be easy to make a landing. But the wind failed, and they were obliged to pass the night at this high altitude. The night was long and cold; before sunrise the thermometer showed —12 to —15 deg. C.

During the night the balloon remained nearly motionless in the air, swinging to the right and left within a small circle. At last the dawn appeared at 6 o'clock and the aeronauts were astonished at the marvelous spectacle which was presented by the Alps at sunrise. All the mountains of the Zermatt, differently illuminated, shone resplendent in the sun, and farther back the eye could distinguish a multitude of peaks and valleys which were still in obscurity. Thus the acronauts were recompensed for their long night's watch. The beneficent effect of the sun was also felt upon the balloon, which commenced to swell out under the expansion of the gas and mounted again, taking a northerly direction. The wind freshened and commenced to take the balloon toward the Oberland. Most of the party expected to be able to clear the Bernese Alps and thus make a brilliant termination of their voyage, but Capt. Spelterini decided that it would be unwise to attempt this enterprise, as there was not enough ballast on board. So it was decided to land the balloon on an elevated point above Bignasco, at an altitude of 5,850 feet. The landing was made at this high point with great difficulty, but without accident, and it was 9 o'clock before the aeronauts



LOHNER-PORSCHE ELECTRIC COUPE.

left the balloon. The captain needed all his experience to conduct the maneuvers of the landing, which took place in a small pasturage bordered by rocks, and as the ground had a steep slope the aeronauts narrowly escaped an accident. The ascension lasted in all about 20 hours. Capt. Spelterini is one of the most experienced aeronauts in Europe, and has already made his 530th ascension; this last trip is the longest he has yet made.

Dr. Maurer, of the meteorological station of Zurich, considers that the present ascension has given a number of data which will be quite valuable from a scientific standpoint. Among other observations which were made, the aeronauts noticed the existence of air currents above the great ice-fields at high altitudes, whose existence has been unsuspected up to the present, and these currents present strange peculiarities for those who are familiar with this kind of observation. A particularly interesting fact in this connection is that a small exploring balloon which was sent up from the Gornergrat and traveled in the direction of Mont Rose, came back to within 150 feet of its starting point, while the observations which were made at the surface of the earth had not shown any change in the wind's direction.

## A NEW TYPE OF GASOLINE-ELECTRIC AUTOMOBILES WITH HUB MOTORS.

By the PARIS CORRESPONDENT of the SCIENTIFIC AMERICAN.

AMONG the novelties in the way of electric automobiles are the new vehicles constructed by the Vienna firm of Lohner-Porsche. They first started with a new form of electric automobile, and afterward combined an electric and a gasoline motor on the same vehicle. The electric system, which is the same in principle for both types of machine, will be described first; then the method by which it is combined with the gasoline motor.

The principal novelty in the electric automobile proper is the use of independent motors, one of which is mounted on each of the front wheels, as the photographs show. The striking novelty is here the placing of the motor body directly in the wheel, so that it forms the hub of the latter. The field of the motor is fixed while the armature, built into the wheel, revolves around it. The fixed part is pivoted on the end of the front cross-bar of the vehicle, so that each wheel is turned independently by its motor. The method of mounting the motor on the front wheels has been recognized as a decided advantage, and can be easily carried out in the case of the electric motor. The Krieger automobile, one of the leading French makes, uses this principle, but here the motor is mounted separately inside the wheel and drives the latter by gearing. The use of twin motors does away entirely with the differential mechanism, as each motor-driven wheel is an independent set, and the wheels can thus turn at different speeds, as is necessary in going around curves. In the Lohner-Porsche system this idea is reduced to its simplest form by incorporating the motor directly into the wheel and doing away with all gearing; consequently it is simpler than most electric automobiles.

A controller mounted below the seat serves to give different couplings of the field and armature windings, combined with an external resistance coil, and so produces the different speeds. The loss in transmission is reduced to a minimum, and an efficiency of 85 per cent is claimed by the inventors. In systems where mechanical transmission is used the loss due to this cause often reaches as high as 50 per cent of the energy of the motor. In the present case the electric motors are built to furnish from 5 to 15 horse power, according to the size of the vehicle. The photographs show a coupé and a light form of electric automobile with accumulators, which furnish the current, while the larger car is built on the combined gasoline-electric type which is to be described. The coupé of two places inside and the driver's seat has a motor giving from 5 to 12 horse power. Using a Planté battery this vehicle makes a trip of 27 miles on a single charge, while with a pasted-plate battery it can cover 75 miles. The controller allows for five speeds ahead and reverse. The average speed is 20 miles an hour. The controller is operated by the handle at the farther end of the seat and is located underneath. The steering wheel is inclined, and to its lower end is connected a gear which works the rod connecting the two wheels. The wheels, being mounted on pivots are thus turned together for the steering. The battery is contained in a box which is slid from the rear into a space under the carriage seat; this space is slightly extended by a box at the rear, but the latter is kept as small as possible. An attractive little vehicle is shown in the second view. In appearance it is lighter than the former, but contains four places. The motors are somewhat smaller, giving 8 to 10 horse power. The batteries are also smaller, and are placed under the front seat. Besides these vehicles, a large brake of 16 places, using two motors of 24 horse power, has been constructed; the batteries, which are contained in a swinging box underneath the body, allow an 80-mile run without recharging. A number of delivery wagons of the same system are now running in Vienna and Budapest, proving quite successful.

Starting from the electric automobile as thus constructed, the inventors proposed to combine the electric motor system with a gasoline motor. This idea has been proposed for some time past, and while some experimental machines have been built, especially in France, the Lohner-Porsche seems to be the first successful automobile of this kind. Jenatzy, a Paris constructor, had a combined machine at the Paris automobile show of 1901, but nothing has been heard of it since. Then M. Louis Krieger took up the idea, and is now constructing a vehicle of this kind. The object of the combined system is to secure the good points of both the electric and the gasoline motor without the drawbacks which are peculiar to each. The gasoline motor is inferior to the electric in many points, as it is more noisy running; then the control of the mechanism is not so easy, and especially, is not progressive. The speed in one case is changed by shifting a set of gears or belts, for which a more or less complicated mechanism is used, while in the other a simple controller does all this. The gasoline motor, in common with other combustion motors, has a low efficiency, while that of the electric motor is, of course, much higher. By combining the electric with the gasoline system, the advantages of the former are secured, while the great drawback of the latter, the use of heavy accumulators, is practically done away with, as a comparatively small battery suffices for the outfit. The system comprises a gasoline motor driving a dynamo which furnishes current for the motors, and also charges a small set of accumulators which can be thrown into the motor circuit if necessary. The battery employed here is kept charged, and is only used occasionally to help out the gasoline motor when the automobile requires the maximum power. In this case the size of the gasoline motor is reduced, so that the whole combination is but little heavier than before. Generally a gasoline motor has to be of heavy build in order to provide for severe strains, going up grades, etc., while here the size of the motor is cut down and the battery is used when extra power is needed. The working of this combination will be well understood from the following description of the new 1903 gasoline electric vehicle, which contains the most recent improvements.

The general form of vehicle used here is the well-known Mercedes gasoline car. The carriage body of the "duc-tonneau" variety is mounted on two pairs of wheels of the same size. The radiator occupies the end of the front box, and just back of it, protected by the cover, is a four-cylinder, 20-horsepower gasoline motor of the usual type, but presenting this difference, viz., that it works always at constant speed. Coupled to it on the same shaft is a dynamo which furnishes current for the motors and batteries. The dynamo is of the six-pole type and has a maximum capacity of 21 kilowatts. The motors, mounted in the front wheels, while of the same general type as the former, have been reduced in size. A small storage battery is placed under the seat in a removable box. The battery is kept charged by the small excess of current which is not taken up by the motors. The batteries thus constitute a reserve of energy which can be called upon when needed, and a simple movement of the controller throws both dynamo and batteries on the motors, which gives them a double supply of energy for a certain time, such as may be needed for mounting heavy grades, passing over rough places or obstacles, etc. In an ordinary automobile a much larger motor would be needed to provide for such cases, while here the motor is much smaller and the weight thus gained is replaced by the battery. The combination, without being much heavier than before, has the decided advantage of using an electric instead of a mechanical transmission from the motor to the wheels. The controller gives all the different speeds of the vehicle, as the motor and dynamo, once started, do not vary in speed. The controller is located under the center of the body, and is worked by a lever next to the steering wheel. It gives a number of different speeds by varying the combinations between the batteries or the dynamo and the different circuits of the motors; it throws the motors on the dynamo circuit alone, on to the battery, or to both the latter combined, besides short-circuiting the motors and allowing them to act as electric brakes. In another position of the controller the motors, when going down hill, can be used as dynamos and help to charge the batteries.

The motors on the front wheels are of a newly-patented type, and a complete description has not yet been furnished by the inventors. It may be stated, however, that the inner field is fixed and consists of twelve radial magnet poles. Around it and fastened to the wheel turns the armature, whose outer casting serves

as a protecting cover for the motor. The Planté solid lead battery is preferred for this type of vehicle, as here it plays only a secondary rôle. This form is more solid and has the advantage of allowing a high discharge for a short period, and as the battery is only called upon in emergencies, this property is useful here. The battery in fact can give an amount of energy nearly equal to that of the motor for a short time. The dynamo keeps the battery charged to its full capacity; in ordinary running it soon becomes charged and after that takes but little energy.

The use of a combined electric and gasoline system gives another advantage over the ordinary automobile, that of having two independent sources of energy, so that if the gasoline motor should have a breakdown, the battery will suffice to run the vehicle for a time and allow it to reach a point of supplies or repairs instead of being left on the road in the open country as so often happens. An accident to the battery will be of minor importance, as the vehicle can run a long distance with the gasoline motor, provided the roads are good.

This system has been in use for only a short time, but it is already attracting considerable attention. Since the Panhard & Levassor firm have secured a license for its employment in France, it is likely to become well known before long. In a succeeding article it is proposed to give some additional details as to the construction of the motor and the other devices which, owing to the question of patents, cannot be published at present.

## NICKEL STEEL: ITS PROPERTIES AND APPLICATIONS.*

By ALBERT LADD COLBY.

IN 1899 in discussing the well-known paper of Mr. James Riley, the father of nickel steel, Mr. Snelus remarked that Shakespeare told them that they might find "tongues in trees, sermons in stones, books in running brooks, and good in everything," and those who had studied meteorites appeared to have overlooked the fact that the metallic meteorites consist largely of alloys of iron and nickel, the practical applications of which they were now for the first time becoming acquainted with, in alloys of iron and nickel produced by themselves. "He was ashamed that he, himself, had so long overlooked Nature's teachings."

While my search through the Proceedings of Scientific Societies for the past 80 years shows that Mr. Snelus was a little severe in his criticism of his fellow iron masters, inasmuch as the advantages of alloying nickel with iron and steel have been known and acknowledged by many investigators over a long period of years, it is nevertheless true that Mr. Riley was the first to publish a series of practical experiments proving the valuable properties possessed by nickel steel, and pointing out many of its important applications.

In 1822 Stodart and Faraday published their experiments made at Sheffield in the alloying of nickel with iron. A little later Berthier made some similar experiments in France.

In 1830, Wolf, of Scheinfurt, Germany, put some nickel-iron alloys on the market, which he called "Meteoric Steels." They were damasked, and Liebig comments on their magnificent appearance in a note in the Annalen der Pharmacie, and states that this alloy is destined to be developed in the near future.

In 1853 Fairbairn published some experiments undertaken to determine the strength of some alloys of nickel and iron similar in composition to meteoric iron.

At the exposition held in New York, in 1853, Philip Thurber exhibited several samples of nickel steels produced from a nickeliferous limonite.

In 1858, Sir Henry Bessemer made an experimental 3 per cent nickel-iron alloy, with a view of making what he termed "Meteoric Iron Guns." He did not, however, pursue the subject, nor publicly refer to the matter until 1896.

Percy, in his "Metallurgy," published in 1864, refers to experiments conducted by Richardson in his (Percy's) laboratory on nickel-iron alloys varying from 1.00 to 50.00 per cent in nickel.

In 1870, Alex. Parkes, of Birmingham, took out several patents for the production of alloys of iron and steel.

In 1883, John Gamgee made nickel-iron alloys in Connecticut.

In 1884, A. M. Clark, of London, patented the manufacture of a malleable ferro-nickel.

In 1885, ferro-nickel was manufactured at Marbeau's Works, at Montataire, France, under the supervision of Bertheault.

In 1887, highly carboniferous nickel steels were made experimentally at the steel works at Imphy, France.

In 1888 and 1889, several French and English patents for the manufacture of nickel steel, and its applications, were granted to Marbeau, Schneider, Riley, and Hall.

It is therefore evident that the advantages of alloying nickel with iron and steel have been known for some time. The credit of making the first systematic series of practical tests on nickel steels belongs, however, to Mr. James Riley, then of Glasgow, whose elaborate paper on "The Alloys of Nickel and Iron" was read by him before the Iron and Steel Institute of Great Britain on May 8, 1889. From a discussion of this paper it appears that J. W. Hall, of Sheffield, had been working on similar lines to Mr. Riley, but his results had not been publicly put on record. Mr. Riley's paper gave the impetus to the introduction of nickel steel in a commercial way.

Since Riley's practical and suggestive paper, the technical men of many steel works in France, Germany, Great Britain, and America have made nickel steel, studied its physical properties and have put it on trial for a wide variety of purposes. In this work they have been aided by consumers looking for a better material, by the scientists connected with the technical universities in each country, as well as other independent investigators.

* Extract from a paper read at the July meeting of the American Society for Testing Materials.

### MANUFACTURE OF NICKEL STEEL.

No detailed reference to the melting of nickel steel and its subsequent rolling, forging, and machining is possible within the scope of this paper. As is well known, nickel steel is melted in both the acid and basic open-hearth furnace, in the Bessemer converter, and in the crucible. From personal observation, the writer has found that the valuable properties of this special steel have been recognized and applied by the principal steel makers of Great Britain and the Continent, as well as by several of the steel melters of America. The physical constants of the metals, nickel and iron, are so closely allied, a fact proven by their occurrence in metallic meteorites, that no special precautions, other than those incident to good melting practice, are necessary during any of the above standard processes of steel melting, in order to insure a *thorough mixture* of the nickel and iron in the manufacture of nickel steel of any desired percentage of carbon, and with or without the presence of special elements, such as chromium, manganese, tungsten, molybdenum, etc. This fact is of great practical importance, especially in such applications as armor plate, marine and stationary shafting, and engine forgings, rails, and bridge material which necessarily involve the casting of large masses of this special steel. Precautions must be taken in the rolling or forging of nickel steels, and especially in their final heat treatment; the steels below 15.00 per cent nickel are also more difficult to machine than simple steels of the same carbon content. These difficulties have, however, formed no serious barrier to its successful introduction for a wide variety of purposes.

### PHYSICAL PROPERTIES OF NICKEL STEEL AS COMPARED WITH CARBON STEEL.

When the physical properties of nickel steel, as compared with those of carbon steel, are better known and more fully appreciated, the amount now used for the purposes for which it has already been successfully introduced will be considerably augmented and new applications will undoubtedly result. It is appropriate, therefore, to review some of the more striking physical properties, obtained as suggested by Snelus, by "following Nature's teachings and alloying nickel with iron."

The modulus of elasticity or "coefficient of elasticity" of such materials as steel which have a well defined elastic limit is determined by dividing the tensile stress in pounds per square inch at any point in the test below the elastic limit, by the elongation per inch of length produced by said stress. The modulus of elasticity which may therefore properly be regarded as the measure of the stiffness of the material is remarkably constant in steel notwithstanding great variations in chemical analysis, temper, etc. Young's modulus is practically the same for both tool steel containing 1.40 per cent carbon and for the mildest steel used in boilers. The modulus of elasticity of steel is in fact rarely found to be below 29,000,000 or above 31,000,000, and is generally taken at 29,500,000 or 30,000,000 in engineering calculations.

A prejudice exists against nickel steel in the minds of some engineers owing to items which have appeared in the technical journals that the modulus of elasticity is lower in nickel steel than in carbon steel. The fact is, however, that while the high nickel steels, especially those containing 20 per cent nickel or over, do have a lower modulus of elasticity than carbon steel, nickel steels containing say 4 per cent of nickel or less, such as are applicable for shafting, forgings, bridge construction, rails, etc., have the same modulus of elasticity as carbon steels, viz., in the neighborhood of 29,000,000 pounds per square inch.

In proof of this assertion, the writer could quote the result of many calculations of the modulus of elasticity of various steels, containing below 5 per cent nickel, made from the detailed records of the physical tests published annually by the United States Army Testing Laboratory at Watertown, Mass., under charge of Mr. J. E. Howard, the accuracy of whose work is beyond question. Evidence could also be cited from the experiments of foreign scientists such as Mercadier, Wedding, Rudeloff, and Guillaume, all of whom support the above assertion that the presence of 4 or 5 per cent of nickel in steel has no appreciable effect in reducing its modulus of elasticity.

If space would permit, a large amount of evidence could be cited to prove that nickel steel is chiefly distinguished from simple carbon steel by its proportionately high elastic limit. Furthermore, if 3 per cent nickel is alloyed with an open hearth steel of 0.25 per cent carbon, it produces a metal equal in tensile strength to a simple carbon steel of 0.45 per cent carbon, but having the advantageous ductility of the lower carbon steel.

On low carbon steels not annealed, the addition of each 1 per cent of nickel up to 5 per cent causes approximately an increase of 5,000 pounds per square inch in the elastic limit and 4,000 pounds in the ultimate or tensile strength. The influence of nickel on the elastic limit and ultimate strength increases with the percentage of carbon present, high carbon nickel steels showing a greater gain than low carbon nickel steels.

In short, the addition of nickel to steel raises the proportion of elastic limit to ultimate strength and adds to the ductility of the steel. This effect of nickel in increasing the ratio of elastic limit to tensile strength, without sacrifice in ductility, accounts for the increase in the working efficiency of nickel steel over carbon steel, in other words, its increased resistance to molecular fatigue.

The comparison of the results obtained from a large number of tests cut from full-sized prolongation of forgings of both carbon steel and nickel steel shows that for a given tensile strength the presence of 3 to 4 per cent of nickel increases the elongation and to a greater extent the contraction of area. On the other hand, comparing simple carbon steel and 3 to 4 per cent nickel steel of the same carbon content, the nickel steels will be found to have from 35 to 40 per cent greater tensile strength with practically the same elongation and contraction of area as the simple carbon steel. This increased ratio in the nickel steel, of ductility to elastic limit and tensile strength, is another index of its increased value over carbon steel and for purposes where in service the material must resist severe and sudden shocks or rapidly repeated alternating stresses.

The exhaustive series of experiments made by Wedding and Rudeloff show that the resistance to compression of nickel-iron alloys increases steadily with the per cent of nickel present, until 16 per cent of nickel is reached. Hadfield has also made a very complete series of experiments on the resistance of nickel steel to compression. He has found that a steel containing 0.27 per cent nickel shortened, under a compression of 100 tons (224,000 pounds) per square inch, 49.90 per cent in a length of 1 inch; a steel with 3.82 per cent nickel shortened 41.38 per cent; with 5.81 per cent nickel 37.76 per cent, and with 11.30 per cent nickel only 1.05 per cent. He states that an ordinary mild carbon steel without nickel, under similar conditions would be shortened 60 per cent to 65 per cent. He also states that the increased resistance to compression of nickel steel is not due to its hardness; an important point in the practicable application of nickel steels where machining is necessary. He argues that the toughening action of nickel when added to steel is caused by a very intimate combination of the molecular structure and that this advantage is further enhanced by the fact that the nickel does not show a disposition to segregate in steel like other elements; in other words, it appears to be more intimately combined.

A striking illustration of the ability of nickel steel to resist compression was exhibited to the writer in 1900 by Holtzer & Co. A cylinder 7.87 inches in height, 6.97 inches external diameter and walls of 0.73 inch in thickness cut from a nickel steel gun hoop, was compressed by a load of 886 gross tons down to a height of 4.72 inches. The internal fibers were thereby extended 46 per cent, and without the formation of any cracks. The superior stiffness of nickel steel over carbon steel without any sacrifice in its toughness has been proved in numerous applications coming under the writer's observation; this combination of properties forms one of the strongest arguments in favor of the use of nickel steel for a wide variety of applications where the service demands a rigid as well as a strong, elastic, and tough material. H. A. Wiggin states that, in his experience he found that nickel steel under the drop test gives better results than carbon steel, even in a greater ratio of superiority than exists in the comparison of the tensile tests of the two steels.

J. G. Eaton made a comparative test of nickel steel plate and carbon steel plate with a view of subjecting both plates to the same strains as those experienced by bottom plating. Both plates were riveted to angles in a manner intended to imitate the riveting of a ship's plate between the frames. A round faced punch placed on each plate was then struck by a heavy falling weight. Each plate endured thirteen blows before rupture and at the next blow each plate showed a clear aperture; that in the carbon steel plate, however, was 23.1 square inches in the clear, while the aperture in the nickel steel plate was ¾ of a square inch; a ratio, therefore, of 30.5 to 1, in favor of nickel steel. D. H. Browne states that a 3 per cent nickel steel shows about 48 per cent greater stiffness and 45 per cent greater toughness than carbon steel; the word "stiffness" referring to the amount of deflection produced by the blow, while the word "toughness" refers to the number of blows required to produce the rupture.

Nickel steel will resist bending both before and after quenching better than carbon steel of similar tensile strength. This has been strikingly illustrated in a long series of practical tests made on nickel steel plates by Mr. Beardmore at his Parkhead Steel Works at Glasgow, Scotland. These tests included quench bends, cold bends, and also cold bending tests of the nickel steel plates with holes drilled in the tests prior to the bending. The results of Hadfield's careful experiments on the bending properties of cast and forged nickel alloys, varying from 0.27 to 49.65 per cent of nickel, may be summarized in his statement "that from about 2.50 to about 6 per cent nickel the bars certainly showed greater bending angles than those of any other iron alloys experimented on," by him.

In a series of comparative tests of carbon steel and nickel steel, such as is used for forgings, made at the works of the Bethlehem Steel Company, the writer obtained bending tests on the unannealed, annealed, and oil-tempered nickel and carbon steels which show the superiority and freedom from brittleness of the nickel steel. A comparison of the physical properties of the two steels is as follows:

| Heat treatment given to each steel. | Lbs. per sq. in. Tensile strength. | Lbs. per sq. in. Elastic limit. | Elongation, p.c. in 2 inches. | Contraction of area per cent. |
|---|---|---|---|---|
| Annealed carbon steel... | 109,500 | 51,440 | 19.50 | 30.31 |
| Annealed nickel steel.... | 100,330 | 66,720 | 25.00 | 54.50 |
| Oil-tempered carbon steel | 129,360 | 67,230 | 17.50 | 38.53 |
| Oil-tempered nickel steel. | 103,890 | 76,390 | 25.00 | 61.56 |

It has been definitely proved that a very low carbon steel cannot be made hard by the mere addition of nickel. Nickel steel is tougher than carbon steel but is not harder, in the true meaning of this latter term. The hardness of nickel steels, below about 15 per cent of nickel, depends upon the proportion of nickel and carbon jointly. Thus while a steel with 2 per cent nickel and 0.90 per cent carbon cannot be machined, a steel with 3 per cent nickel and 0.60 per cent carbon can be machined. The freedom from hardness of comparatively low carbon nickel steel is strikingly illustrated by the writer's experience in cutting with a penknife the rifle barrels made, at Bethlehem, of steel containing 4.50 per cent nickel and 0.30 per cent carbon, and yet this steel had an elastic limit of over 80,000 pounds, and a tensile strength of over 100,000 pounds per square inch. At 20 per cent of nickel, as stated by Riley, successive increments of nickel tend to make the steel softer and more ductile, and even to neutralize the influence of carbon.

Nickel steel resists torsion or twisting stress better than the same class of carbon steels. Riley's experiments indicate that it is not necessary to use steels

high in nickel to obtain the best effect in torsional resistance. The writer has found that several of the French steel works have appreciated this property of nickel steel by applying it for the manufacture of special wire and springs.

The rigidity and toughness of nickel steel make it a desirable metal where, in service, the material is subjected to wear or abrasion. Practical evidence of this statement is found in the three years' comparative trial of nickel steel and carbon steel rails on the "horse-shoe" curve of the Pennsylvania Railroad, which has recently resulted in orders being placed for some 10,000 tons of nickel steel rails for the sections of the tracks of the Pennsylvania, Baltimore & Ohio, and New York Central & Hudson River Railroad, where in the past frequent renewals of the carbon steel rails have shown their inability to withstand the severe abrasion due to the sharp curves and heavy traffic.* Further evidence of the value of nickel steel to withstand abrasion is found in the results of experiments carried on by one of the French railroads in the trial of nickel steel for locomotive tires.

The coefficient of expansion of nickel steel varies greatly with the percentage of nickel present; especially in the series of nickel steels containing from 20 to 45 per cent of nickel. The 36 per cent nickel steel called in France "invar" (from the word "invariable") has a lower coefficient of expansion than any other metal or alloy known. Guillaume, of the International Bureau of Weights and Measures, the best authority on this subject, and whose opinion is also supported by other experts, states, however, that there is no practical difference between the expansion of simple carbon steel and of steel containing up to 5 per cent of nickel. In the use, therefore, of low carbon 3 to 5 per cent nickel steels in bridge construction the same allowance for expansion can be made as when carbon steel is used. This is an important point especially when both carbon steel and nickel steel are to be used in the same structure. The different coefficients of expansion of steels containing from 30 to 45 per cent of nickel have resulted in their application in France and Germany for a wide variety of purposes, which will be referred to later.

Beardmore, the Scotch steel maker, after an elaborate series of tests, places the loss of strength due to punching ordinary mild steel at 33 per cent of the original strength, and claims that the loss of strength in punching nickel steel varies from 15.5 to 20 per cent of the original strength, and furthermore that on thicker sections of nickel steel plate the loss of strength is only about 10 per cent. A number of other experimenters have also found that nickel steel plates are not weakened by punching to as great an extent as carbon steel plates. There is ample evidence that the presence of nickel in steel increases its shearing strength. This is important especially in connection with riveted work, as the strain on the rivet is not a simple strain but rather a shearing or cutting action. Moreover, in the shearing of nickel steel rivets, the fracture is fibrous and the metal appears to have torn gradually, whereas in ordinary carbon steel rivets, the metal breaks off short.

From the results of a comparative test made at Bethlehem on nickel steel and carbon steel rivets, the conclusion was drawn that "it may be safely deduced that a ¾-inch nickel steel rivet will replace a 1 1-16-inch or even possibly a 1⅛-inch common steel rivet, thus effecting a saving of considerable plate section and giving increased strength." Experiments made by Beardmore, Abraham, and Rudeloff and at the Creusot Steel Works also testify to the increased shearing strength of nickel steel rivets, and experiments made by the Société Denain and d'Anzin prove that 5 per cent nickel steel rivets possess over twice the shearing strength of iron rivets. Browne states that the sheared edges of carbon steel plates often cut ragged whereas nickel steel cuts clean.

### SEGREGATION.

The writer's opinion, based upon a large number of chemical analyses made at Bethlehem, is that nickel in itself segregates but very slightly even in large armor plate and shafting ingots. This is natural as the atomic volume, atomic weight and specific gravity of nickel are similar to those of iron.

Some experimenters testify that nickel tends to check the segregation in steel of the other elements such as sulphur, phosphorus, carbon, manganese, and silicon. Mr. Hadfield thinks that the tendency of nickel to check segregation is probably due to the fact that it raises the melting point of the carbides or cementing material and causes the whole mass to set more nearly together, and quotes in proof that nickel steel ingots have a finer grain than carbon steel ingots. Mr. Chase, of the Midvale Steel Company, states that "nickel is supposed to lessen the segregation and liquidation of carbon by combining with the carbon which cements the particles of iron together, and thus bringing the specific gravity of the carbon compounds nearer to that of the rest of the alloys in the fluid mixture. It also seems to cause this cementing carbon to solidify at more nearly the same temperature as the other alloys."

Mr. Campbell, of the Pennsylvania Steel Company, made a series of tests to prove what he states to be the current impression among manufacturers of nickel steel that the presence of this element prevents segregation. His conclusion is that there seems to be good ground for the assumption that nickel prevents the separation of the metalloids, but that it does not prevent it altogether, and he states that it is not probable that any other agent will ever be found competent for this task.

Within the limits of this general review, it is impossible to refer in detail to the interesting subjects of the heat treatment, the critical points, the molecular relation of nickel to iron and carbon, and the microstructure of nickel steel; the effect of extreme temperatures and the electrical and magnetic properties particularly of steels containing over 20 per cent of nickel. Sufficient evidence has, however, probably been presented to prove that nickel steel possesses many advantages of practical importance over simple carbon steels, and the engineer looking for a trustworthy material will be convinced by what has been presented, that it is safe to give nickel steel a practical trial.

*See remarks of Messrs. John McLeod and C. B. Dudley.

## THE HEAVENS AND THE STARS.

UNTIL the time of the elder Herschel observing astronomers were chiefly concerned with the structure and arrangement of the solar system. The larger question of stellar arrangement was usually approached from the side of pure speculation. Herschel's problem was, in his own weighty words, "to find out the construction of the heavens," by which he meant the structure of the sidereal system or systems that make up the visible universe.

There are three fundamental questions to be asked and answered, which lead to a multitude of minor and subsidiary researches, each one of difficulty and delicacy.

First. We may inquire as to the extent of the universe of stars. Are the stars numberless? Are the stars that we see but a small part of an infinite congeries, most of which are destined to remain forever unknown to us on account of the imperfect power of our telescopes? In other words, are stars faint because they are very distant, or are they faint because they really lack intrinsic brilliancy? Are brilliant and small stars mingled together at the same distance from us, or are the more brilliant the nearer, the fainter the further off? Do we see the stars that lie at the very borders of the universe?

Second. What is the arrangement of the stars in space? The visible night-sky shows an expanse dotted with points of light, across which stretches the luminous band of the Milky Way—the Galaxy—which we know to be made up of scores of millions of the fainter stars. Does the Galaxy form a stellar system? Is our own sun a member of this system? Or is the universe made up of discrete and, as it were, independent groupings?

Third. What is to be the duration of the stellar universe in time? Is it fitted to endure forever or does it implicitly contain the formula of its own dissolution? Will it, in the course of ages, necessarily be transformed to be something quite unlike its present self?

It is only within a few years that questions such as these could be put with any hope of definite replies, and even now the answers to them are of very different degrees of authority. But important steps have been made. In the first place, the construction of great and ever greater telescopes has shown that in certain well-studied regions, like that about the nebula of Orion, for example, the increase in the number of stars shown by an increase in telescopic power is by no means proportional to the power employed. This indicates that the number of stars is finite, not infinite. If, again, the stars were infinite in number the whole background of the heavens should be illuminated, unless indeed light is absorbed and lost in a long journey through space. Measures now in hand will soon throw much light on the latter point; but at the present time it seems that light is not extinguished in space, and as a consequence, that our universe of stars is finite, not infinite; that the stars are not countless.

How are the stars, as we see them, distributed in the sky? A study of all available data has led Prof. Seeliger, of Munich, to a conclusion that is certain. The Milky Way is no merely local phenomenon, he concludes, but is closely connected with the constitution of our entire stellar system. That system is, speaking generally, one grand system, not a collection of mutually independent swarms. Another fundamental datum referring to stellar clusters is stated by Prof. Newcomb, of Washington, as follows:

The agglomeration of the brighter stars into clusters—like those of the Pleiades, Præsepe, and Orion—does not extend to the fainter stars. The brighter stars are clustered in these cases and we see them projected upon a background studded with fainter stars scattered according to a very different law of agglomeration. This rule is true for clusters in general; it does not apply to the clusters of the Galaxy.

A study of all the clusters—those included in the Milky Way as well as those exterior to it—has led Newcomb to a conclusion which is supported by the researches of others upon the same question, namely: If we should remove from the sky all the local aggregations of stars and also the entire collection which make up the cloud-forms of the Milky Way, we should have left a scattered collection, constantly increasing in density toward the Galactic belt.

Take a celestial globe and mark upon it the course of the Galaxy; call this great circle the Galactic Equator; find the north and south Galactic poles; draw small circles about these poles—circles of equal Galactic latitude. It is announced that the stars along these parallels of latitude increase in number according to their proximity to the Milky Way itself. The stars in general form a system—one system, whose obvious characteristic has just been formulated. The universe is an organism.

Within a couple of decades the parallaxes of a considerable number of stars have been measured, and the distances of these stars from our sun have thus become known.

Let us imagine the sun to occupy the center of a series of concentric spheres. The smallest sphere has, let us say, a radius 200,000 times as great as the radius of the earth's orbit—a radius 200,000 times 93,000,000 miles. Call this radius, for convenience, $R$. The second sphere lies outside of the first and its surface is $R$ miles beyond that of the first; the surface of the third sphere is $R$ miles beyond that of the second, and so on. Now, it is a fact that within the first sphere, whose radius is $R$, no star exists save and except the sun at its center. Within the second sphere there is one star (Alpha Centauri) and no more, so far as is known. Within the third sphere there are four stars; within the fifth there are twenty-eight; within the tenth there are but eighty-eight. Making all allowances it is fair to conclude that, on the whole, the stars are so sparsely scattered that their average distance apart is a space over which light would take six and a half years to pass. We are to remember that in eight minutes light travels from the sun to the earth.

Comparing these results with photometric measures of the brightness of stars and with countings of their number in definite regions of the sky Newcomb reaches the conclusion that we have no reason to believe the stellar universe (leaving out of account the Milky Way) to extend far beyond the sphere whose radius is 1,000 times $R$—beyond the distance of 1,000 times 200,000 times 93,000,000 miles. The stars of the Milky Way, he concludes, certainly lie beyond the sphere whose radius is 400 $R$, perhaps beyond the sphere of 1,000 $R$. The stars of the Milky Way are situated at a greater distance than the probable confines of the universe in the direction of the Galactic poles.

Our own solar system seems to lie not so very far from the center of the stellar universe. It certainly lies near the median plane of the Milky Way. How far away from its center we are situated will not be known with a fair approximation until the photographic charts of the heavens, now making, have been finished and their data discussed.

The venerable dean of English science, Dr. Alfred Russel Wallace, has very recently printed his reflections upon the foregoing results. He assumes that the earth is at the center of the cosmos and that it, alone, out of all the planets, known and unknown, is fitted to be the abode of human beings, and draws the conclusion that the supreme end and purpose of all this vast universe was the production of the living soul in the perishable body of man. This is a conclusion that makes a vivid appeal to the vanity of mankind and it is sure to be seized upon with gladness now, just as the pronouncement of the Roman theologians that the earth was, in very truth, the center of the solar system and that the theory of Copernicus was false and heretical, was hailed with joy. What possible virtue resides in the central point of a sphere that may not equally reside in its circumference? If, indeed, we happen to occupy the center of the sphere at this moment (which is very doubtful) we shall not long continue to do so. The whole solar system is moving through space at the rate of twelve miles per second, about 370,000,000 miles per annum. The earth has moved a matter of 700,000,000,000 miles since Christ was born in Bethlehem. Men have lived upon the earth at least 100,000 years, and their habitation has, in this time, moved through at least 37,000,000,000,000 miles. Is not, then, the contention of Dr. Wallace that the position of the earth has aught to do with the pre-eminence of man utterly without significance?

It is very likely that Dr. Wallace is correct in saying that only one of the eight planets of our system is now fit for human habitation. But our sun is only one among at least 100,000,000,000 other suns. Is it unlikely that these suns are surrounded with planets? Suppose each such sun to have eight planets of its own; is it unlikely that among 800,000,000,000 planets there may be a thousand—or a hundred thousand—now fit for human life?

Dr. Wallace's contention may safely be left to one side as speculative and unfounded in the extreme.

The visible universe is, in all likelihood, limited in extent; its boundary is somewhat indefinite and irregular and lies at such a distance that light requires about 3,000 years to pass from that boundary to us; the universe of stars is in the general form of a flattened disk; the total number of stars is to be counted by hundreds of millions. Such are some of the most far-reaching conclusions enunciated in Prof. Newcomb's masterly volume on "The Stars." Each of them has its roots far in the past.

Not to speak of the speculations of the ancients, the foundations were laid by Galileo, Kepler, Herschel, Kant, Lambert, Michell before the first years of the last century. A host of workers has contributed to the edifice since then, each bringing a stone, until it has reached a consistent and massive impressiveness. It may be likened to the cyclopean walls of prehistoric times. Researches are now in progress—especially the photographic charts of the entire heavens—that will bring the first hewn blocks for the basis of a grander and completer structure. We may look forward with perfect confidence to the time when a finished temple, strict in all its proportions, shall be erected by many skillful hands for the inspiration and the pride of men. Let us recognize that we have now among us those who will, for all time, be applauded as master builders.—E. S. Holden in the New York Sun.

## CÆSAR'S SHORTHAND WRITERS IN THE ROMAN SENATE.

EVEN before the days of printing presses Cicero introduced a system of shorthand reporting, called the Tyronean method, from Tyro, a freedman, who was one of Cicero's most expert writers. That even at that early date systems of shorthand writing—stenography—came into general use for certain purposes, and that the methods were very effective, we may infer from a passage in Horace, who, when addressing a shorthand writer, says: "You write in such a manner that you will have no occasion in four whole years to ask for another sheet of parchment."

Julius Cæsar, bidding for popularity in his first consulate, caused the proceedings of the Roman senate to be published daily, and these reports were taken down by trained writers, who were called tabularii, being what we to-day style reporters. These reporters were probably only rapid writers using the ordinary characters. The reports were revised and edited before their exposure to the public eye, and were then circulated even in the distant provinces—just the same as the Congressional Record is now sent to the constituents of members of our Congress. Prior to this time the great annals of the lawmakers were written on tablets and placed in a room of the pontiff, where they were accessible to the public. The people had to go to the "newspaper," and it was not delivered at their homes as now. This room of the pontiff was a general reading room, reminding one of the periodical room of the Congressional Library.

Why the ancients had no printing presses it has been difficult for students to decide, for they had the material for making them and paper and parchment for printing, and then, as now, there was a heavy and growing demand for reading matter. It was

not until the material for writing changed that there was much progress in the matter of spreading the news. The decalogue was written upon tablets of stone; the Athenian record, now known as the Parian Chronicle, was engraved upon tablets of marble, and next we find inscriptions on thin plates of metal and on the broad leaves of certain plants, on sheets formed of woven texture from the bark of trees, and on the skins of animals. These heavy and cumbrous "volumes" were as difficult to handle as the iron money imposed upon the Spartans.

The Assyrians came nearer to the printing press than did the Egyptians, for they discovered and practised a method of rapidly multiplying their writings, using engraved seals, consisting of cylinders from which any number of impressions could be made. Naturally intellectual advancement was rapid with the introduction of "circulating documents, books and papers," for the reading class was then only the wealthy, even in the best days of Roman civilization. The assembled intellect heard the news at the Olympian games and in the Athenian theater.

Cicero's shorthand reporters were the beginning of the stenographic art, without which we could not get along very well in this age of newspapering. Cicero's plan called only for the taking down and copying of the proceedings of the senate by educated slaves, and these copies were sent out. Cicero worked on the same plan of gaining popularity as do the statesmen who send out the Congressional Record, public documents, and garden seed, and he was unquestionably a pretty shrewd politician. It is gratifying, however, to stenographers of the present day to know that they are not slaves as were the writers and shorthand reporters of those days. True, they have frequently long hours and laborious work, but one of the profession will earn more in a single day than did the ancient reporters in a whole year.

It was, unquestionably, the system of slavery which was the bane of ancient civilization and the primary cause of its ruin. Capital owned labor; therefore, labor was cheap and without dignity. The author dined upon rarities costing thousands of dollars in the case of a single meal, while his slaves who produced his books were nearly starved. The only cost involved in the production of a book was the sustenance of the servile writers and embellishers. Publication was carried on just as a plantation was worked in the days before the war. The largest books, with the most beautiful and expensive bindings, could be produced at a far less cost in dollars and cents than they can be made in this day. And the same reasons which prevented modern improvements in the old slave-holding States prevented the introduction of the printing press as an organ of ancient civilization.

Atticus, a Roman bibliophilist, trained a large number of slaves to the especial duty of merely transcribing. There were five readers for each one hundred trained writers in different apartments, and five hundred copies of a short poem or small book could be produced rapidly and at little cost, less by far than the boasted powers of the press with all our modern appliances in the art of printing. These shorthand slaves could produce in twelve hours five hundred copies of a poem equal in extent to Tennyson's "Enoch Arden" and its accompanying poems, and for this work they received one pound of a kind of common corn each, with a small allowance of wine.—Washington Star.

## THE DESTRUCTION OF TERMITES.

On September 6, 1902, the Pasteur Institute received from London a dispatch from the Chartered Company of South Africa, requesting that an expert should be immediately sent to Rhodesia for the purpose of treating cases of hydrophobia and of taking the measures necessary for arresting the epidemic of rabies that had just made its appearance among men and animals between Zambesi and the Transvaal. My employers were kind enough to propose to me to take charge of this mission, and, on October 22, after establishing a Pasteur Institute at Bulawayo, I began to treat persons bitten by mad dogs. Upon my arrival, the government of Rhodesia made a proposition to me to take up the study of several questions, and particularly that of the destruction of termites. In South Africa, we find a large number of insects of the Termitidæ, or Termite family, as many as two hundred species having been described by naturalists. The most remarkable among these are those called white ants, and which, notwithstanding their name, have no parental relations with the ants properly so called. By the ravages that they commit, these insects constitute a genuine scourge in the countries in which they are found. They live by myriads in subterranean nests and are one of the greatest obstacles to agriculture. It is during the night that these insects accomplish their destructive work. Most of the time, they are invisible and make their peregrinations under the shelter of small tunnels, which they construct upon their way in measure as they move forward. They attack not only trees and vegetables of all kinds, but houses also. Even when the latter appear to be intact, they are often found to have been invaded by these little creatures, which burrow into the woodwork and sap the walls. Although the structure seems to be in a perfect condition, it some day begins to crumble, and it is then found that it is on the point of falling into dust. A lawyer of Bulawayo, upon his return after a week's absence, found an invasion of these insects, which had done irreparable damage to his house. He had to abandon his study and take up quarters elsewhere. Eight days had sufficed for these devastators to raise a formicary of the height of a man against the chimney.

FIG. 2.—WOOD DAMAGED BY TERMITES, AND NESTS OF THE INSECTS.

I have seen cases preserved in houses and containing wine imported from Europe in bottles, the corks of which had been eaten by termites. When the cases were opened, the bottles were consequently found to be empty.

The formicaries are very frequently met with, standing at a short distance from each other. At the top of the cone-shaped mound, 15 or 16 feet in height, that constitutes the formicary, is seen a yawning aperture running nearly horizontally. This is the entrance.

As with the ordinary ants of our own climate each formicary constitutes a small republic. Each of these little states comprises a female or queen, a male, and a number of neuters. These latter are subdivided into workers, which constitute the most numerous people of the habitation, and other subjects of a greater size armed with very powerful mandibles. These are sentinels, whose mission it is to watch over the city and defend it.

The formicary consists of galleries excavated irregularly and all ending in a larger gallery that may be considered as the main avenue of the subterranean city. This leads to the very bottom of the latter, where is situated the habitation of the queen. After the sovereignty has been assigned to a female, the workers pluck off her wings and shut her up in a cell adapted to the size of her body, which, at the outset, is no longer than that of a very small woodlouse. As the queen needs a consort, the latter, after being selected from among the males, is immured in a contiguous cell provided with an aperture that puts it in communication with the one occupied by the female, which the consort then proceeds to visit.

The female soon undergoes a notable change. Up to the thorax, her dimensions are scarcely any greater than those of any other termites, but her abdomen soon begins to increase and presents the aspect of a long, stiff, flabby, whitish mass striped with brown bands that differentiate her *in toto* from all the other inhabitants of the formicary. Such increase is due to the enormous quantity of eggs contained in the abdomen. One female suffices to populate a formicary in a very short time, since the oviposition reaches a figure of several thousand eggs a day. As soon as the eggs are laid they are seized by workers who carry them to certain cells, according as they contain the larvæ of males, females, or neuters. As a general thing, there is but one queen to each nest, but in some large formicaries that I opened I sometimes found two or three. I once took a clod of earth filled with ants from a formicary of which I had destroyed the queen. Eight days afterward, I opened the receptacle into which I had put the clod, for the purpose of examining it, and, in one cell, found a female whose size was commencing to increase, and who had sentinels mounting guard around her. I had before me all the interior arrangement of a large formicary that this little world had organized in a week. And it had even given itself a queen! The body of the males has a certain resemblance to that of wasps. The thorax is separated by a slender peduncle from the abdomen, which has the dimensions of a large pea. The sentinels, which are especially designed for the defense of the domain, have highly developed heads and their mandibles are armed with huge fangs capable of inflicting a severe wound in the hand that is exposed to them. The workers are nearly half an inch in length.

All this little world gravitates around the royal quarters, which form the center of the internal organization of the domain. These small, but formidable enemies of man have also implacable adversaries in ants having the same habitat. Two contiguous formicaries do not live in peace, even if they are peopled by individuals united by ties of race. The most formidable enemies of the white ants are large black ants called Matabeles, doubtless because of their color, which is analogous to that of the natives of the country—the inhabitants of Matabeleland. Their size considerably exceeds that of their congeners. A legion of the Matabeles suffices to spread terror throughout an entire city of the white ants. Much stronger than the latter and armed with powerful mandibles, the invading blacks seize as many as a dozen at once and carry them quickly to their formicary. Why do these ferocious warriors fall unawares upon the white ants? Why do they snatch these unfortunate insects, which do them no harm, from their city and work? The Matabele, in making a violent irruption upon its cousin german, is not guided by a sanguinary instinct, but on the contrary. It will do its captive no harm, but, being content to keep it a prisoner, will take good care of it, since it is necessary to it. Less active, less diligent, and less dexterous than the white ant, it has need of the industrious worker as a servant. The latter will labor in the domain of its masters, will construct comfortable cells for them, will take care of their larvæ like a good mother, and will construct for them fine tunnels that will permit them to go from one place to another under shelter from rain and wind, both of which are greatly dreaded by ants. That is why we find entire tribes of white ants living in society with the Matabeles. In the formicaries there are often parasites which the ants tolerate. Upon opening an ant's nest, I once saw a snake nearly six feet in length, the coils of which were wound around the roots of a tree over the habitation of the queen.

But ants, both large and small, have a general enemy in the ant-bear that swarms in these regions, where it finds a prey as easily captured as it is numerous. All hope is gone when one of these animals enters their nest. That, however, does not prevent the fearful number of termites from increasing and multiplying. In places, the nests of these insects occupy such an extent of territory as to form genuine little villages. Their inhabitants attack everything and devour everything; roots are cut, and leaves, of which they are very fond, are eaten up. They hollow out and empty the interior of branches, so as to leave nothing but the bark, and the tree soon falls into dust. In the municipal park of Bulawayo, there is but one tree left out of fifty planted, and it is estimated that the damage done in the city by this genuine scourge of South Africa amounts to the figure of $50,000.

An endeavor has been made to get rid of these injurious insects to as great a degree as possible, but up to the present there has existed no practical means of exterminating them. Sulphide of carbon and dynamite have been employed, and at one time even a reward of 60 cents was offered to all those who should destroy a termite queen, so as to retard the swarming of the insects.

In a lecture delivered at Bulawayo, September 17, 1902, I said that the more that I studied the white ants, the more I was convinced that the extermination of these insects was possible by means of an apparatus, that of Clayton, the action of which I had been studying for nearly two years in the destruction of rats on board of ships. The tunnels and galleries that these insects construct form an *ensemble* of tubes, owing to which the Clayton sulphurous gas, which has a great power of diffusion, can easily be distributed throughout every portion of the formicary and cause destruction therein. The question was an interesting one for study, not only to Rhodesia, but also to all other tropical regions in which termites exist. I therefore proposed to the government to have one of

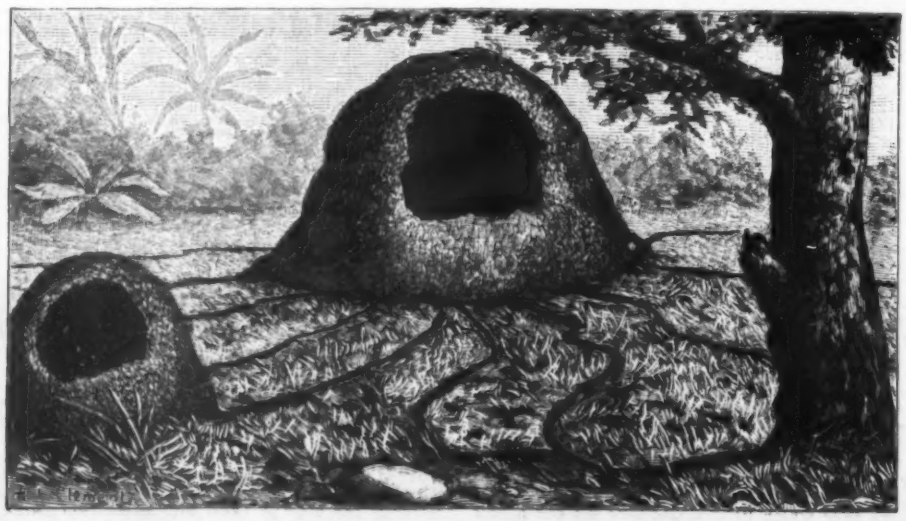


FIG. 1.—NESTS AND GALLERIES OF TERMITES.

these apparatus imported in order to study the action of it. Upon the arrival of this in Rhodesia it was immediately installed and utilized.

One of the pipes is placed in the aperture of the formicary. This pipe, owing to the blower with which the apparatus is provided, introduces the sulphurous gas. A hole is formed at a few yards' distance in order that the second pipe may be placed in the prolongation of the formicary. The air of the galleries is exhausted, passes into a furnace, where the sulphur burns, becomes charged with asphyxiating vapors and is introduced into the nest, which, in less than an hour, is filled with gas. The experiments are proceeding at the present moment under the supervision of M. A. Pease, my preparator, and are giving good results. One of the first was made in the house in which, upon my arrival, I established the Pasteur Institute. One of the pipes was placed under the floor of the porch and the other in one of the rooms of the house. Upon raising the floor after the operation, there was found in the earth a large tunnel into which the termites carried their booty. The entire colony therein was discovered to be dead.

Some other experiments were made in other houses, and in open air in the park. The nests were easily filled with gas, which destroyed all the insects, eggs, and larvæ. It is a cheap process that may possibly render services in the French colonies where termites do thousands of dollars' worth of damage every year. In the session of the Geographical Society of the 22d of May last, M. Le Myre de Vilers said that the ravages caused by termites at Saignon cost some years more than two million dollars.

Termites are fortunately very rare in France, where they are found only in Saintonge. They were found for the first time at Rochefort in 1797. Rochelle underwent the same fate as Rochefort, the prefecture and a few neighboring houses being the center of depredation. One day, says Quatrefages, the archives of the department were found to be almost totally destroyed and that, too, without a trace of damage being exhibited externally. The termites had reached the cardboard boxes by mining the woodwork, and then, at their leisure, eaten the administrative papers, while carefully respecting the upper sheet and the edge of the leaves, so that a box filled merely with shapeless detritus seemed to contain files of paper in a perfect state.—Translated from an article by Dr. A. Loir, in La Nature, for the SCIENTIFIC AMERICAN SUPPLEMENT.

## TUSKS THAT SELL FOR THOUSANDS.

R. VAN BAEB has for years been prominent in the ivory industry of the Congo, which is now the greatest source of ivory in the world. He has recently written a series of articles on the ivory industry, which have just been published in Le Mouvement Geographique. Some of the most interesting facts, particularly those which are not widely known, are reproduced here from his exhaustive treatment of the subject.

Ivory is derived from the secretion and solidification of gelatinous matter called dentine, which is contained in the hollow part (pulp cavity) of the tusk. This matter is conveyed through minute veins extending radially to the surface of the tusk, where it hardens in concentric layers. The surface of the ivory is covered with a crust about three millimeters thick, which is removed before the ivory is turned into any industrial product.

An intimate relation exists between the age of the elephant and the rapidity of ivory growth. The young animal secretes a much larger quantity of dentine than an old elephant. Its tusks are hollow almost to their point.

This hollow part or pulp cavity gradually decreases

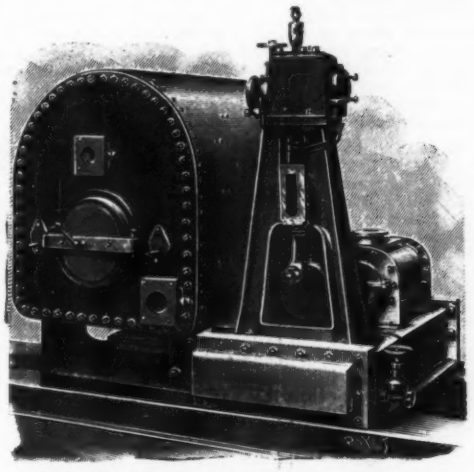


FIG. 4.—CLAYTON APPARATUS FOR THE DESTRUCTION OF TERMITES.

in size with advancing age. About three-fourths or four-fifths of each tusk of old animals is solid ivory.

Another way to tell whether the tusk comes from a young or an old animal is to examine the hollow part of it. If the hollow is of the same diameter where the tusk emerges from the head as at the furthest end of the hollow, the tusk is that of an adult animal.

Some writers have referred to the large number of small tusks in the market as proof that elephants are killed for their ivory before the tusks mature. The fact is that more than two-thirds of the ivory sold is that of adult animals.

It is from the older tusks of solid or nearly solid ivory that billiard balls are made. Most of the elephants are killed by the natives, and ivory hunting is with them a secondary consideration. Their chief reasons for killing the elephant are that he destroys their plantations, and that his flesh is regarded as an excellent food resource.

Elephants have not been so recklessly destroyed in Africa as in India, where the wild elephant is now almost unknown. It will be remembered that in India, on account of their destruction of crops, wild elephants were for a time poisoned in large numbers.

Many tribes which organize great elephant hunts in the Mobangi region of the Congo impair the value of the ivory by driving the herd into an inclosed space and then setting fire to the tall grass, so that the animals are nearly burned to death before they are finally killed with spears. The tusks are thus more or less calcined and their value is greatly reduced.

The elephant is found in all the well-watered and fertile parts of equatorial Africa. The finest and most transparent ivory is obtained from the humid and low-lying regions.

In the higher and colder districts the ivory is coarser in texture. Along the frontiers of the animal's habitat his ivory becomes very hard and brittle, as, for example, the ivory coming from Senegambia.

About one-fifth of the tusks coming from central Africa are affected by some strange disease, the results of which are seen in little masses or threads of a substance that differs from ivory in structure and composition. They are harder than ivory, darker in color, and evidently originate in some interference with the secretion of the dentine. The Germans call this disease "ivory smallpox."

The tusks that come into commerce greatly vary in weight, with about two pounds as the minimum. The maximum weight is not definitely fixed. One pair of tusks from the same animal that recently came to Europe weighed a little over 316 pounds, or about 158 pounds to the tusk.

Tusks are occasionally found of even greater weight. One enormous tusk, for example, weighing 206 pounds, was sold a few years ago to the late King of Bavaria to serve as the principal piece of a chandelier.

The most remarkable pair of tusks that has yet been obtained in Africa was purchased at Zanzibar two and a half years ago, for the large price of $5,000. They were taken from an elephant that was killed near Mount Kilimanjaro, German East Africa, by an Arab, after he had chased the animal for many weeks.

His attention was attracted to this particular elephant by its enormous size, but much time and patience were expended before he got near enough to put in a killing shot. The tusks weighed 459 pounds, one weighing about twenty pounds more than the other. One tusk was slightly longer than the other, and measured 10.16 feet.

One of the classifications of ivory is based upon the weight of the tusks. A heavy tusk weighs twenty-five kilogrammes or more; medium tusks from eighteen to twenty-five kilogrammes. The smaller tusks are adapted for bangles, bracelets, billiard balls, and other such purposes. About 30 per cent of the stock imported into Antwerp is heavy tusks, and about 57 per cent medium tusks, the smaller tusks making up more than half of the total.

The form of the tusks also varies greatly. The longest tusk yet obtained measured 10.16 feet. As regards their form, tusks occasionally come into the market that are absolutely straight, but they are very rare.

Sometimes a tusk is found which has curled around, forming almost a perfect circle. Such pieces are defective, and their usual form is apparently due to some disease in the ivory. They are usually without any hollow interior, and if they continue to grow must necessarily penetrate into the flesh of the head.

Frequently an elephant's tusks are not of the same length or weight. This is due to the tendency of most of these pachyderms to give preference to one or the other tusk in defending himself, in digging up the soil, or in any other use of his tusks.

The particular tusk that is used more than the other is likely to be a little longer and heavier. Thus, as among human beings, there are right-handed and left-handed men, so there are many elephants that give the larger part of the work and exercise to the right or left tusk.

The tusks of the domestic elephant are likely to be longer, more slender, sharper, and also more curved than are those of the wild animals. There also exists a species of elephant that has no tusks. They have been found in the delta of the Rusisi River and in certain parts of the Mobangi River basin.

The fact is not generally known that there exists in the tropical forests a race of dwarf elephants, which are exactly like others except in stature and weight. Thus elephants, as well as antelopes and human beings, have their pygmies.

The three great ivory markets of the world are Antwerp, London, and Liverpool. For the past six or seven years Antwerp has forged ahead of London, for it controls most of the great new field of the Congo. Since 1895 its ivory receipts have invariably exceeded those of London, excepting in 1898. The receipts last year were 323 tons for Antwerp, 208 for London, and 40 for Liverpool—a total of 571 tons.

The total receipts of these markets from 1894 to 1902 ranged between 524 and 620 tons a year. The receipts of London are slowly declining, while those of Antwerp are rapidly increasing, although it is probable that the height of its trade will be reached before many years. Liverpool cuts a small figure in comparison with its rivals, its receipts having varied in the past nine years from thirty-two to sixty tons a year.

The ivory reaching the British market comes from Zanzibar, Bombay, the largest sources of its supply; Egypt, West Africa, and Abyssina, a very large amount also coming from Benguela and the Cape. About one-third of the London ivory comes from the west coast of Africa and Abyssinia, and the supply is decreasing.

The West African ivory has been chiefly obtained from Senegambia, Liberia, the Guinea coast, and the Niger, which have been extensively worked for many years. The supply is failing, though it is now being reinforced by ivory from the Hinterland.

The receipts from Abyssinia reached their maximum in 1900. The important quantities exported from that country in recent years have been due to the organization of large hunts with the best weapons. Hunting the elephant in King Menelik's domain has thus been abormally stimulated of late years, but the supply of ivory from this source is now decreasing.

About 43 per cent of the ivory sent to London comes from the east coast of India; its quantity has been nearly uniform, but the present prospects are that

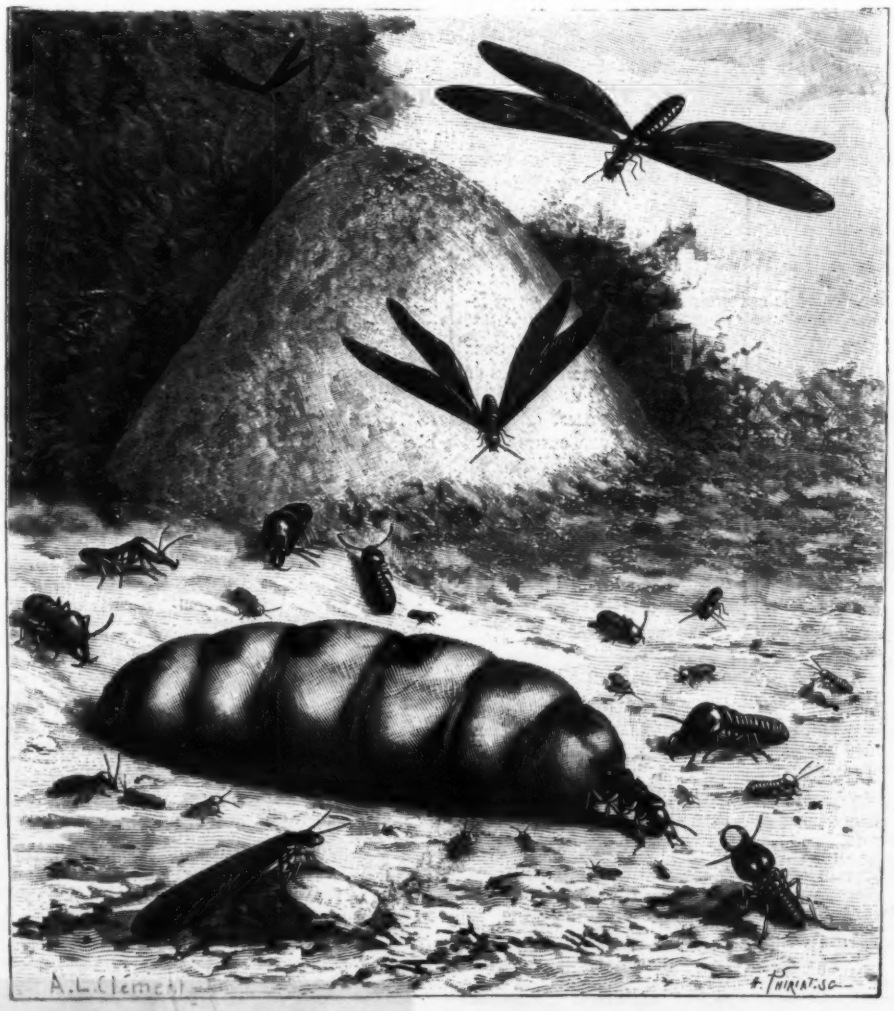


FIG. 3.—WINGED FEMALE, WINGED MALE, AND FEMALE DISTENDED WITH EGGS.

it will slowly decrease. The ivory from Egypt will probably increase in quantity for a few years, owing to the reopening of the Egyptian Soudan.

The Antwerp market came into existence only in 1893, and it had very rapid development, its great specialty being ivory from the Congo Free State. The two great classifications of Antwerp ivory are hard and soft ivory. About seven-eighths of the total supply is hard ivory, which means ivory that has been accumulating in the country for many years, much of it having been collected by the natives before they had any idea of its commercial value.

In 1892 only eighteen tons of soft ivory came from the Congo Free State, though 124 tons of hard ivory were shipped. The soft ivory is the fresh tusks obtained from newly killed animals.

The French Congo includes a very large elephant domain and the French began in 1900 to export ivory from it. The shipments in 1901 were thirty-two tons, and they bid fair during the present year to be fifty or sixty tons. The French Congo will be the outlet for a great deal of ivory in the next few years.

It is not expected that the Congo State can much longer keep up its enormous shipment of ivory. The maximum, to all appearances, will be reached within the next four or five years. Then there will probably come a period of about uniform shipments for a number of years, which will be followed by an era of rapid decline. The day is soon approaching when the reserve stock of ivory accumulated by the natives will be exhausted.

When that source of supply is at an end the ivory industry will decline until railroads open up the far interior of the country in regions not now accessible by steamboats. Then there will be new fields to exploit, for the elephant still lives in numerous herds in some parts of Central Africa, as in the regions of the upper Sanga River, the upper Mobangi, and some large districts of the French Soudan and the Egyptian Soudan. Perhaps these now almost inaccessible sources of ivory will supply the world for a century to come.

The Congo State is now enforcing laws to prevent the glutting of the ivory market and the extermination of elephant herds within the state's territory. It is entirely probable that long before the supply of ivory threatens to fall below the world's demands the other powers interested in Africa will also adopt measures calculated to place limits upon the destruction of elephants and to insure, if possible, the permanence of the ivory trade.—Seattle Post-Intelligencer.

## THE USE OF ROTATING CATHODES IN THE ELECTROLYTIC DETERMINATION OF METALS.

ALTHOUGH rotating cathodes have frequently been used in order to obtain metallic deposits in a compact form, in connection with soluble anodes, F. A. Gooch and H. E. Medway, in a paper published in a recent issue of the Zeitschr. f. anorg. Chem., suggest using such cathodes with analytical separations, in order to eliminate metals completely from their solutions. In such cases insoluble anodes are being used, the fairly high E. M. F. required to overcome the resistance and to accelerate the separation of the metal, resulting in a considerable evolution of hydrogen, so that the metal is not deposited in a compact and adherent form. The authors endeavor to compensate the disturbing effect of the evolution of hydrogen by the use of a rotating cathode, so that even in the case of high-current intensities well-adherent and homogeneous deposits, available for analytical purposes, should be formed in a short time. An ordinary platinum crucible rotating at about 600 to 800 revolutions per minute is used as a cathode, the crucible being driven by a small inexpensive electromotor, arranged so as to have its shaft vertical. To this shaft the crucible was attached by means of a rubber stopper, the central boring of which was traversed by the shaft. In order to insure the electric contact between the crucible and the shaft, a narrow slip of platinum sheet was soldered to the shaft, bent upward beside the stopper and clamped between the latter and the crucible. The shaft is advantageously made of two portions, so that the crucible may readily be dismounted, both parts being connected by a piece of rubber tubing. The solution to be electrolyzed is placed so that the crucible may be immersed into the liquid down to any desired depth. Platinum sheet connected with the positive pole of a battery of four accumulators, connected in series, is used as an anode, the negative pole of the battery being connected to the bearing of the shaft, when the current will pass from the platinum sheet through the solution to the crucible, and thence through the shaft of the motor back to the battery.

It is inferred from the results recorded in this paper that nickel as well as copper and silver are rapidly and completely precipitated by this process. The deposits of these metals as obtained on rotating cathodes are sufficiently coherent and compact to allow of accurate work and weighing, even in the case of the current density at the cathodes being very material and variable between wide limits. Other metals show a similar behavior, and the authors intend giving the results of these additional experiments in a further paper. A. G.

AN addendum to the article entitled "A Simple Circular Computing Scale," which appeared in SUPPLEMENT No. 1437, has been sent us by the author, Mr. James Alexander Smith. It explains more clearly the method of graduating the scale expeditiously and is as follows:

Fully divide the segment 1 to 2 by the methods detailed, then mark off a paper templet to the part 1 to 1.5 and bisect each of the graduations so found. This will give accurately the spacing required between 2 and 3, transfer to that segment. Similarly treated, segment 1.5 to 2 enables 3 to 4 to be set out; 2 to 2.5, 4 to 5; 2.5 to 3, 5 to 6; 3 to 3.5, 6 to 7; 3.5 to 4, 7 to 8; 4 to 4.5, 8 to 9; and 4.5 to 5, 9 to 1. With a little attention two templets may be manipulated to divide the whole circle without the necessity of further referring to the outer circle except, perhaps, as an occasional check.

## ELECTRICAL NOTES.

**Wilson has made experiments** to explain why a negatively charged body exposed to the atmosphere becomes radio-active; as this apparently indicates the presence of some radio-active substance in the atmosphere, he tested whether any of this radio-active substance is carried down in rain. He boiled down freshly fallen rain to dryness and found a radio-active residue. The radio-activity rapidly disappears.

**Joseph Marco,** an employe of the Hudson River Water Power Company, was assisting the electrician recently, when he walked against two live wires, one contact being on the head and the other on the hip, and 20,000 volts passed through his body. He was knocked unconscious, but seems none the worse for his experience, except that he is badly burned at the points of contact with the wires.

**According to the report** by the Director of the National Physical Laboratory on the work of the engineering and physics departments during the half year ended June, 1903, Mr. F. E. Smith's research on the resistance of mercury and the construction of a standard mercury resistance is practically complete. Some ten or twelve tubes have been calibrated, and give results which will only differ among themselves by some few parts in 100,000. On the assumption that the absolute value of the wire standards in the laboratory is known, the length of the column of mercury, 1 sq. mm. in section, having a resistance of $10^9$ C. G. S. units, is found to be almost exactly 106.29 cm. The difference between Mr. Smith's results and those of the Reichsanstalt will not be more than some few parts in 100,000.

**In a paper read** before the Fifth International Congress for Applied Chemistry, held at Berlin, Mr. R. Brandeis deals with the fundamental differences in the constitution of theoretical and practical electrochemistry, the causes responsible for the present development of technical chemistry being generally considered. Really available processes, it is pointed out, have arisen of late years in a comparatively limited number. Some special branches of electro-chemistry are next discussed. As regards metalloids, hydrogen, oxygen, and bromine, apart from chlorine, are chiefly considered, the uses of hydrogen being discussed at some length. Bromine, it appears, is being recovered with satisfactory results at Westeregeln according to Wunsche's process. In electro-metallurgy, aluminium is obtained and copper and nickel refined. As compared with refining, the direct recovery of metals by electro-chemical processes is little developed in Germany, although much labor and money have been expended for some decades in developing suitable methods. In fact, no direct process for recovering copper and tin directly from their ores has so far been devised, the only similar processes of some importance in electro-chemistry being the aluminium and sodium processes, apart from the recovery of gold by the Siemens & Halske method. The chlorate industry is further dealt with by the author, a short historical sketch being given, as well as an account of the uses of hydraulic forces and of some special factories. In connection therewith the importance of alkali chloride electrolysis for the preparation of alkali and soda is discussed and anodical oxidation for the preparation of permanganates and the regeneration of potassium bichromate from the chrome residues in dye-stuff factories, as well as electrolytical bleaching processes, are finally treated.

**The Times states** that an electric railway up Mont Blanc has been designed by M. Vallot, the French savant who built an observatory, which is also an eight-roomed dwelling house, on the Mont Blanc range between the Dome du Goûter and the Bosses du Dromadaire. M. Vallot has in his possession all the plans and documents relating to this projected railway, and has himself made a most careful study of the topography of the whole range. He is of opinion that, although the depth of the Mer de Glace and of the Glacier des Bossons, where they descend into the valley, is considerable, in the higher parts of the range it is very much shallower. There are, moreover, various points where the underlying rock comes through the crust of ice, and these would be chosen as sites for the stations, where travelers would get an opportunity of enjoying the view in the intervals of the tunnels. The proposed tunnel is not to be more than seven miles long, and the journey will not be any more unpleasant than that through the St. Gothard or the Mont Cenis. Starting at Les Houches, the village at the top of the gorge of the Arve, and at the entrance to the Chamonix Valley, the line will follow the direction of the existing path to the Pavilion of the Bellevue. This part of the journey is to be effected by an open-air funicular railway, of the same type as those at Glion and Mürren. Near the top of the ridge the line enters a tunnel, and then follows the trend of the *arete* past the Tête Rousse to the Aiguille du Goûter. Gros-Béchar will be the first station and Aiguille du Goûter the second, where there is a chalet. Up to this point there is little risk of mountain sickness for ordinary travelers, but for those with weak hearts it would not be advisable to proceed further. The next stopping place proposed is the Dome du Goûter, where a magnificent view of the Aiguille du Midi, the Mont Maudit, and of the summit of Mont Blanc itself may be obtained. Another station will be at the saddle of the Bosses du Dromadaire, not far from the Vallot Refuge and Observatory. Beyond this the line will have to pierce more than 200 feet below the surface in order to reach the Petits Rochers Rouges. The remaining 300 yards may probably be covered on foot by the majority of travelers; but in order to make the line complete it is proposed to make a small funicular from the Petits Rochers Rouges to the Janssen Observatory on the actual summit. M. Vallot suggests a rack-and-pinion line, and power will be obtained from turbo-generators fed by the water power of the River Arve, which already supplies current for the Le Fayet-Chamonix Railway. It is estimated that the cost of a ticket to the top of Mont Blanc by this railway will be about £4, which is cheap compared with the £10 or £12 that has to be expended at present on guides, porters, and the expenses of a night at the hut on the Grands Mulets.

## TRADE NOTES AND RECIPES.

**Proper Mixture for Yellow Brass Castings.**—If good, clean, yellow brass sand castings are desired, according to the Metal Industry, the brass should not contain over 30 per cent of zinc. This will insure an alloy of good color and one which will run free and clean. Tin or lead may be added, without affecting the property of casting clean. A mixture of 7 pounds of copper, 3 pounds of spelter, 4 ounces of tin and 3 ounces of lead makes a good casting alloy and one which will cut free and is strong. If a stronger alloy be desired, more tin may be added, but 4 ounces is usually sufficient. If the alloy be too hard, reduce the proportion of tin.

**Process for Bronzing Cast Iron.**—The Maschinenbauer describes the following process for imparting to common cast iron all the rich glow of bronze, without covering it with a metal or an alloy.

Having thoroughly cleansed the surface and rubbed it down smooth, apply evenly a coat of vegetable oil, say sweet or olive oil, and heat the iron object, being careful that the temperature does not rise high enough to burn the oil.

At the moment of decomposition of the oil the cast iron will absorb oxygen, and this forms upon the surface a brown oxide skin or film, which takes a fast hold and is so hard that it will admit of a high polish, thus bestowing upon the iron a most striking resemblance to bronze.

**Tempered Copper.**—Long and in vain have mechanics and others sought for a method of imparting to copper a greater degree of hardness, a quality of more obstinate resistance.

It has not been so much the question of providing instruments made of this metal with a sharp cutting edge like a razor, as to coat them with a case-hardened surface which shall* successfully withstand the attacks of external influences. According to a patent just published we find that objects made of copper may be satisfactorily tempered by subjecting them to a certain degree of heat for a determined period of time and bestrewing them with powdered sulphur during the heating.

While still hot the objects are to be plunged into a bath of blue vitriol; after the bath they may be heated again.—Leipziger Uhrmacher Zeitung.

**French Zinc.**—"French zinc" is a name applied by various paint manufacturers to a certain kind of zinc white (commercial oxide of zinc), used as a pigment in painting. We were not aware that this particular kind of zinc white was employed in the manufacture of toilet preparations, although zinc oxide is used extensively in various cosmetics. In the powdered form it is very often added to dusting powders, but it is said to have an astringent and drying action on the skin when applied for a long time. A formula containing zinc oxide is given by Piesse under the title:

Perle Powder.

| | |
|---|---|
| French chalk | 1 pound |
| Bismuth oxide | 1 ounce |
| Zinc oxide | 1 ounce |

—Pharmaceutical Era.

**Brilliantine.—**

| | |
|---|---|
| 1. Suet | 40 ounces |
| Wax | 40 ounces |
| Sesame oil | 40 fluid ounces |

Melt in a water-bath, constantly stirring, so as to make a foamy mixture, and add—

| | |
|---|---|
| Castor oil | 21 fluid ounces |
| Tragacanth mucilage (thick) | 21 ounces |

Perfume as desired.

| | |
|---|---|
| 2. Alcohol (60 per cent) | 4 fluid ounces |
| Castor oil | 2 fluid ounces |
| Neroli oil | 20 minims |
| Oil rose geranium | 5 minims |
| Oil verbena | 5 minims |
| Oil lemon | 50 minims |

Color yellow with saffron.

| | |
|---|---|
| 3. Alcohol (90 per cent) | 3 fluid ounces |
| Castor oil | 2 fluid drachms |
| Expressed oil almond | 1½ fluid ounces |
| Glycerine | 4 fluid drachms |
| Extract jockey club | 1 fluid drachm |
| 4. Lard | 3½ ounces |
| Spermaceti | 3½ ounces |
| Expressed oil almond | 3½ fluid ounces |
| Wax | 1 ounce |

—Oils, Colours, and Drysalteries.

**The Druggists Circular and Chemical Gazette** publishes the following:

Of the various agents recommended for cleansing the teeth by friction we prefer chalk for general use.

The "prepared" form is the proper one, and it should be free from gritty matter. Many other substances which are directed in the various tooth powder formulas which have been published are too hard, and are thus likely to scratch the enamel and from this the teeth may sooner or later be ruined. The chalk is pleasanter to use when slightly flavored, and coloring renders it more agreeable to some eyes. A good formula is appended for

Rose Tooth Powder.

| | |
|---|---|
| Prepared chalk | 4 ounces |
| Powdered orris root | 2 ounces |
| Oil of rose geranium | 15 minims |
| Oil of sandal wood | 5 minims |
| Cochineal coloring, N. F., a sufficient quantity | |

Triturate the chalk and orris together, gradually adding the coloring until the desired tint is attained; then add the oils and continue the trituration until they are uniformly diffused through the mass. More certainty of securing uniform distribution of color and perfume can probably be attained by thoroughly triturating the coloring matter and oils first with a small portion of the powder and then rubbing this through the remainder. Of course, in this case the small portion taken must be much more highly colored than the finished powder is intended to be.

Another form of dentifrice may be made by mixing equal parts of the powder made by the foregoing formula, and powdered white Castile soap.

## TRADE SUGGESTIONS FROM UNITED STATES CONSULS.

**Beet and Cane Sugar as Industrial Factors.**—In a review of a book on "Sugar Production and Sugar Premiums," by Max Schippel, Das Handels Museum of July 16, 1903, official organ of the Austrian government, publishes matter of almost universal interest. It says, among other things, that certain neglected fields have been investigated and facts furnished that can not fail to be of interest to all who participate in any way in the production and distribution of beet or cane sugar. Attention is first called to the enormous interest India has in the maintenance of the old, primitive methods of boiling the sugar. The writer then deals with the disastrous catastrophe that has overtaken and almost overwhelmed the sugar plantations of the West Indies. Attention is called to the West Indians' powerlessness to compete with the beet-sugar producers of Europe; also to the difficulties that beset the path of North American sugar producers because of inadequately trained labor. In regard to the results that are expected to follow the aims and efforts of the recent congress of sugar-producing countries held at Brussels for the purpose of finding a way to avoid disastrous competition and premium paying, the paper quotes Schippel as follows:

"In the competition between the former premium-paying countries, the dismantling of the factories of individual participants does not make such a very great difference."

In other words, no very noticeable change has been effected. As far as relatively favorable positions are concerned, Germany, under the arrangement proposed, would come out ahead. The sugar production of its neighbors, particularly France, would lose more than Germany. The separate or special favors granted by the congress to Italy, Sweden, and Spain, says Mr. Schippel, conceal no new danger, but rather some profitable features compared with the present situation. These countries, by staying away from the conference, could have enacted or kept such sugar laws as would ultimately have raised them to the position where they would be able to provide for themselves. Italy is almost at that point. Sweden, with her premiums and protective tariffs, was able, as far back as 1901-2, to get along without sugar imports. Spain, whose sugar supply consists of two-thirds beet sugar and one-third cane sugar, is producing more now than the nation needs. Special care has been given to the beet-root sugar industry since the colonies were lost. Plans are on foot for reducing the production by effecting a union of some kind of all those interested in the production of sugar. The participation of these states in the conference has led to one good thing, viz. that when they become sugar-exporting states, if they ever do, they will be bound by the treaty or agreement arrived at in the conference (article 6). On the other hand, they are already bound to find compensating measures against the sugar that comes in from premium-paying countries. Thus, so far as they import sugar at present, they must seek their supply, or the largest part of it at least, in the lands bound by the contract. The careful watching of sugar in transit will be of value.

Mr. Schippel says, further, that one needs to have no fear of Russia. She opposes export premiums, in consequence of her system of lawmaking, and claims in all cases, on the basis of the most-favored-nation clause, exemption of her sugar from customs penalties. Still, her position in this respect has been exceedingly unlucky. In 1887-88, at the London conference, Russia joined those, without any reserve, who claimed that compensating duties did not violate the most-favored-nation clauses. Since 1897 the United States treats Russian sugar as a product to which a premium is paid. In 1899 India began to do this. Nowhere has Russia's claim been allowed. Now, if all the other interested parties—England, Germany, Austria-Hungary, her ally France, Belgium, Holland, Spain, Italy, and Sweden—oppose her, is Russia going to remain in opposition? It is easier to think of her joining the convention, or that she would turn to the development of Asiatic markets—India excepted—and to supplying her own home market with its wonderful possibilities of development and expansion.

The reform propositions put forth by Russia about the middle of February, 1903, would indicate a tendency toward the solution just indicated. Mr. Schippel, after careful consideration of the question whether cane sugar is ever again to occupy its old place in the industrial world in comparison with beet-root sugar, replies in the negative. He sees no reason for thinking there is to be any very great change. He points out the possibilities in the sugar industry and claims that the German market is reserved for the factories of the Fatherland. He says its powers of expansion are enormous—so much so that in case of necessity it can be made to take the largest part of what the empire exports. The present consumption in England, he says, is nearly 98 pounds per capita per annum; in Germany, only 30 pounds. By the time the Germans consume 98 pounds per capita per annum there will be little of the empire's present sugar production left for exportation.

There were very considerable markets in which the two sugars—cane and beet-root—met, but always to the ultimate disappearance of the former. Witness Louisiana's cane sugar in competition with the beet-root product of the northern section of the United States. No one dreams of ever seeing the cane sugar drive its rival from the field.

Since the introduction of compensating duties the European premium-paid sugar finds itself upon the same plane as the imports of the normally taxed and not specially favored cane-sugar imports. This is true of the East Indies and the results are the same. France tried by means of complicated regulations to help its colonies in producing cane sugar, but to no purpose. The production fell off and the beet-root sugar industries prospered. The same, with slight modifications, is true of Spain and Holland. Although German sugar got the smallest premium it was able to drive cane sugar from the English markets. Experience goes to show that the fears, long entertained, in regard to beet-root sugar are groundless. Against them is the history of all tropical development. Tropical colonies will never have the intellectual power to expand and to move forward such as characterizes the electrical, almost tireless, movements of Europe. The men to unite the sciences with practical life, the perennial stream of expert farmers, chemists, and technicians, recruited from the middle classes, are impossible in the tropics, where no such middle class exists. Capital will always have to count on enormous risks in the tropical colonies. These are the devastating forces of nature, various kinds of fevers, the uncertainties that attach to the workings of social institutions, the hostility of races, the failure of all law and order at times. The money needed from the sowing of seed to the harvesting, or from the beginning of an undertaking till the sale of the product, is not to be had and the financial organization for its control is far inferior to that of Europe. The greatest obstacle is found in the inability to properly organize labor. Whether one begins by building up small farms or by running huge plantations—worked by negroes and coolies, who are paid by the day, week, or month—the result will remain always the same. The production will be small and uncertain, as are all labor arrangements based upon the one-sided idea of one man's will. It is true that the tropical colonies have built up a better type of labor since the abolition of slavery. Both capital and labor have been benefited thereby; but, in many cases, hopes based upon these better conditions have been dashed to pieces. It often happens now that such hopes are destroyed. Where, however, they have not failed, but the good work has gone on and the people have persevered, the reward has not been wanting.

**Drawbacks to American-Spanish Trade.**—Regarding the commercial activity of Madrid, so far at least as it relates to American importations, I can report favorably. There are several houses here that import American goods, such as electric machinery, tools, plows, pumps, hardware, and patent medicines, directly from American manufacturers, and one American firm—the Holt Manufacturing Company, of San Francisco—has come into the Spanish market with large farming machinery, to which, however, the farm laborers, who form the largest and best-organized union in Spain, do not take kindly, and a short time ago banded together in the north of Spain and destroyed one of these machines.

In general, American goods are favorably received and find a ready market. That which stands in the way of a better and more profitable commercial intercourse between the United States and Spain is the lack of a commercial treaty. The tax on American goods is almost prohibitive, and the merchants are forced to get American goods from France, Germany, or England. As a rule, such goods enter Spain under French, German, or English labels. If these goods are praised, they are praised at the cost of Spanish-American commerce, and it ought to be our pride to sell American goods as American goods. Perhaps a more serious obstacle to the development of a direct Spanish-American commerce is the lack of confidence with which American manufacturers treat the Spanish merchants.

This consulate is in receipt of hundreds of letters from manufacturers and exporters in the United States for names and addresses of firms in Madrid for the purpose of sending catalogues, hoping thereby to receive orders for the various articles they offer for sale. I may state here, quite positively, that nothing will ever result from such proceedings. The merchants, as a rule, admire the pictures in the "books," but never think of them as a means to a commercial end. What the American manufacturers ought to do is to send goods on consignment to responsible firms.

In the sale of goods directly to merchants here, they ought to give reasonable credits. This would, in a measure, counterbalance the high duties. It must be borne in mind that German and other European manufacturers, selling their goods far below the American in price, also extend to the Spanish dealer a long credit. Added to this is the evident lack of faith and respect with which the American manufacturer treats the Spanish dealer, as the following case will illustrate. A Madrid business house sent an order for a certain kind of goods and with the order also sent the money. The American house did not have the specified article in stock and sent another and wholly useless article, stating, "This is what we have on hand; hope it will go." The article did not "go," and the house here has been unable to get any satisfaction from the firm whose self-interest ought to have inspired it to make reparation.

I can not emphasize too strongly the fact that Spanish merchants are, as a rule, honest and take pride in the "perpetuity" of their houses. They are, therefore, afraid of the shadow of a dishonest act, and if they pay slowly they pay none the less surely. I would therefore urge American manufacturers to come into this market boldly and generously.—Adolphus Danziger, Vice-Consul at Madrid.

**American Trade Openings in Germany.**—In his annual report covering the trade and commerce of Stettin for the year ended June 30, 1903, Consul John E. Kehl writes as follows concerning trade openings for American manufacturers:

Brooms.—Brooms are very expensive here, and, as a rule, are made of very poor corn. Whisk brooms are practically unknown in this district. The import duty on coarse brooms with rough handles is 3 marks (71 cents) per 100 kilogrammes (220.46 pounds).

Shoes.—Shoes of American shapes and styles are becoming very popular; the sign "American fashion" on even German-made shoes is very common. The import duty on common shoes is 50 marks ($11.90) per 100 kilogrammes; on fine shoes, 65 marks ($15.47) per 100 kilogrammes. Under the new tariff, not yet in force, the duty will be from 85 to 180 marks ($20.23 to $42.84) per 100 kilogrammes.

Cloth.—In many of the tailoring establishments, English cloth is used. In display windows small tags bearing the legend "Real English" can be often seen. Why not "Real American"? Samples with width, length, and weight of bolt would be the safest means of ascertaining the import duty.

Furniture.—If some enterprising furniture manufacturer would make a common bedroom set, after German style in every respect, consisting of single bed, clothes closet, commode, and washstand, with probably two chairs to match, he could, in my opinion, find a good market. Abundance of cheap lumber, with the assistance of labor-saving machinery, should put the American in position to manufacture considerably cheaper than here. The import duty on furniture is 10 marks ($2.38) per 100 kilogrammes.

Bench Tools.—The American article in this line is, as a rule, lighter, more practical, and more durable than the German make. As to price, I firmly believe that the local article can be undersold.

Agricultural Implements.—Farm implements, such as hoes, rakes, axes, forks, etc., compare with the local article the same as bench tools. With a live agent, capable of speaking the language and with a full line of samples, some business could be done. Long-time credit forms a great feature of German trade; many complaints have been made that the Americans are too severe in their terms and do not care to fill small orders. This condition of affairs is just contrary to what the German is accustomed to and is the cause of the loss of many orders. In most cases it is policy to cater to the whims of a good customer—a fact which England and Germany thoroughly appreciate in dealing with other nations.

**Miners' Wages in Germany.**—The annual report of the Oppeln Chamber of Commerce says the average wages of coal miners over 16 years of age in Silesia fell from 1,029.7 marks ($245.14) in 1902 to 972.1 marks ($231.33) in 1903, a difference of nearly 6 per cent. There was a reduction of wages in the years 1892 and 1893—years of almost universal depression. Comparisons will show an increase, however, of fully 66 per cent in the last fifteen years. The average wage-workers' pay is only taken as a useful statistical norm. It includes the work of the expert and the apprentice, the able worker and the invalid. While in 1899 the average of 917 marks ($218.25) was set over against each workman above 16 years of age, the actual amount paid to miners in a certain section of Silesia was 1,169 marks ($278.22). The helpers of various kinds were paid as follows: Drivers, 729 marks ($173.50); carpenters, etc., 994 marks ($236.57); general help in the mines, 698 marks ($166.32); above the mines, 724 marks ($172.55). Thus, the average of more than 90 per cent of the help employed in these Silesian mines was above 1,200 marks ($285.60). If these figures are applied to the actual miner, it will be found that his wages went up fully 6 per cent during the year 1902. It will be seen also that the wages paid to the miners who pick out the coal is in many cases more than 1,200 marks ($285.60); in a great many, 1,300 and 1,400 marks ($309.40 and $333.20); and in a few, 1,500 and 1,600 marks ($357 and $380.80). The report says that the same favorable conditions are to be noted in connection with the wages of iron-workers.

**Exporting Goods to Germany.**—In trading with the district of Mainz, and the same holds good, more or less, for all other districts of Germany, American exporters should be careful to have it always clearly understood, if wares are sold by weight, whether the weight is gaged by the metric or avoirdupois system, as the metric pound is about 10 per cent heavier than the avoirdupois pound and the metric system is the standard gage of the German Empire. Articles which are sold in original packages, such as cereal foods and the like, should be packed according to the metric weights, viz., in half-kilogramme, 1-kilogramme, 5-kilogramme (1.1023, 2.2046, and 11.023 pound), etc., packages.

Transportation to Mainz is most easily and cheaply effected by the water route—ocean freight to Rotterdam and thence by barge up the Rhine River. Freight rates on the Rhine are lowest in spring and summer.

As regards the facilities for handling freight in the harbor of Mainz and as to general information regarding opportunities for trade in this section, I beg to refer to my annual report dated September 24, 1898 (vol. ii., Commercial Relations, 1898), as the advice therein given by me still holds good.

Besides the customs duty levied by the empire, the city of Mainz collects an octroi duty on a number of articles brought into the town.—Walter Schumann, Consul at Mainz.

**German Textile Mills in the United States.**—Several manufacturers in the Glauchau district are considering the advisability of establishing branch factories in the United States. A prominent manufacturer in Meerane has already established such branch factory, and is now opening 150 looms at Garfield, N. J., and a Gorlitz manufacturer is building an extensive plant at Norwalk, Conn.—E. A. Creevy, Consul, Glauchau.

## INDEX TO ADVANCE SHEETS OF CONSULAR REPORTS.

**No. 1766. October 5.**—Extension of British Colonial Preferential Tariffs—South African Imports.

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**No. 1768. October 7.**—Agricultural Implements and Vehicles in Foreign Countries.

**No. 1769. October 8.**—Reports: Important Step in Electric Traction—German-Asiatic Trade—German-South American Trade—Mr. Moseley's Industrial Inquiry—Notes: Ostrich Farming in Australia—Fine Woods, Rubber and Gums in Mexico—Projected Railway in the State of Veracruz, Mexico—Porto Rican Sugar—Austrian Floating Exhibition—Industrial Establishments in Russia—Tea Cultivation in Persia.

**No. 1770. October 9.**—Reports: Commerce and Industries of British Guiana for 1903—French Exporters' Cruise to the Levant—Coal Imports of Tampico, Mexico—Scientific Inventions and Experiments—Education and the Elimination of Crime—Germany's Trade in Dyes and Chemicals—New German Red-phosphorus Match—Notes: Foreign Trade of Austria-Hungary—Alcoholic Liquors in German Africa—Agricultural Position of Spain—Increased Export Duties on Wood in Haiti—New Revenue-stamp Law in Haiti.

**No. 1771. October 10.**—Reports: French Tariff Changes—Flower Culture for Distilling in Southern France—Manufacture of Perfumes in Grasse—Uruguayan Commerce and Public Works—Destruction of Cork Forests of Italy—German Trade Journals—England's Trade Relations—New Steel Process—English, French and German Trade in 1903—Westphalian Coal Syndicate—German and Foreign Flags at Hamburg—Notes: Tariff on Cracked Oats in Venezuela—Effect of the Canadian Preferential Tariff Law—*Wire Netting Needed in Portugal—*Duty on Packages to Holland.

Other Reports can be obtained by applying to the Department of Commerce and Labor, Washington, D. C.

## SELECTED FORMULÆ.

**Coating for Damp Walls.**—Thirty parts of tin are dissolved in 40 parts of hydrochloric acid, and 30 parts of sal-ammoniac are added. A powder composed of freestone, 50 parts; zinc oxide, 20 parts; pounded glass, 15 parts; powdered marble, 10 parts, and calcined magnesia, 5 parts, is prepared and made into a paste with the liquid above mentioned. Coloring matter may be added. The composition may be used as a damp-proof coating for walls, or for repairing stonework, or for molding statues or ornaments.—Journ. Gas and Sanitary Engineering.

**French Polish.**—A French polish can be made as follows; though rather complicated, it is worth the trouble: Take one pint of soft water, and mix with it twice as much vinegar; break in small pieces one quarter pound of glue; stir it into the vinegar and water with half a pound of logwood chips, a quarter ounce of finely-powdered indigo, a quarter ounce of the best soap, and a quarter ounce of isinglass. Put all this mixture on the fire, and let it boil gently for at least a quarter of an hour; strain it carefully, put into bottles and cork tightly. When cold it is ready to be used. A clean, soft sponge should be used to apply it.—Pharmaceutical Era.

**Stove Dealers' Blacking.**—

| | |
|---|---|
| Plumbago | 1 pound |
| Resin | 4 ounces |
| Benzine | 1 gallon |

Dissolve the resin in the benzine, and mix the plumbago with it. It is said to give no offensive smell when the stove is used, and to keep the iron from rusting. Another process for a good liquid stove blacking is to mix with powdered plumbago enough asphaltum varnish to form a thick paste and to add to it sufficient spirits of turpentine or benzine to bring the mixture to the required degree of thinness.—Pharmaceutical Era.

**Paste That Will Adhere to Tin.**—

| | |
|---|---|
| Tragacanth in powder | 2 parts |
| Boiling water | 40 parts |
| Wheat flour | 6 parts |
| White dextrin | 1 part |
| Cold water | 4 parts |

Mix the tragacanth with 16 parts of boiling water, stir well and set aside. Mix the flour and dextrin with the cold water, and add it to the tragacanth. Have the residue of the water in active ebullition, and pour it on the mixture, stirring it vigorously while it is being poured. To the result add 1 part of glycerin, and the same amount of salicylic acid, put on the fire and let the whole boil for 3 or 4 minutes, stirring all the time. The addition of about the quarter of 1 per cent butter of antimony to an ordinarily good flour or starch paste will make it adhere to tin; in fact, there are a number of substances that may be added that will have the same effect, ammonia water, aluminium sulphate, etc.—Nat. Druggist.

**Liquid Metal Polish.**—

| | | |
|---|---|---|
| 1 Rotten stone | 16 | av. ounces |
| Paraffin | 8 | av. ounces |
| Kerosene (coal oil) | 16 | fl. ounces |
| Oil of mirbane, enough to perfume. | | |

Melt the paraffin, incorporate the rotten stone, add the kerosene and the oil of mirbane when cold.

| | | |
|---|---|---|
| 2 Oxalic acid | ½ | av. ounce |
| Rotten stone | 10 | av. ounces |
| Kerosene (coal oil) | 30 | fl. ounces |
| Paraffin | 2 | av. ounces |

Pulverize the oxalic acid and mix it with rotten stone; melt the paraffin, add to it the kerosene, and incorporate the powder; when cool, add oil of mirbane or lavender to perfume.

| | | |
|---|---|---|
| 3 Pumice | 2 | av. ounces |
| Rotten stone | 2 | av. ounces |
| Iron carbonate | 2 | av. ounces |
| Paraffin | 2 | av. ounces |
| Gasolin | 16 | fl. ounces |

Mix the pumice, rotten stone, and iron; pass through a fine sieve to remove all grit. Melt the paraffin and pour into the gasolin; to this solution now add the powder, with shaking to thoroughly incorporate the same.—Meyer Brothers' Druggist.

**Original Formula for Cologne Water.**—While formulæ for the original "Kölnischeswasser" from the original shop of Johann Maria Farina, "gegenüber dem Julichsplatze," are plentiful, unfortunately none are reliable. The following, however, is stated to be, on what appears to be good authority, the original recipe:

| | |
|---|---|
| Oil of bergamot | 96 parts |
| Oil of citron | 96 parts |
| Oil of cedrat | 96 parts |
| Oil of rosemary | 48 parts |
| Oil of neroli | 48 parts |
| Oil of lavender | 48 parts |
| Oil of cavella | 24 parts |
| Absolute alcohol | 1,000 parts |
| Spirit of rosemary | 25,000 parts |

Mix and dissolve.

We would remark, here, that in making Cologne water, the alcohol used should be that obtained from the distillation of wine, provided a first-class article is desired. It is possible, of course, to make a good cologne with very highly rectified and deodorized corn or potato spirits, but the product never equals *caeteris paribus*, that made from wine spirits. Possibly the reason for this lies in the fact that the latter always contains a varying amount of œnanthic ether.

Another Formula.

| | |
|---|---|
| Oil of bergamot | 10 parts |
| Oil of neroli | 15 parts |
| Oil of citron | 5 parts |
| Oil of cedrat | 5 parts |
| Oil of rosemary | 1 part |
| Tincture of ambergris | 5 parts |
| Tincture of benzoin | 5 parts |
| Alcohol | 1,000 parts |

Mix and dissolve.

—National Druggist.


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